Electrical Review

THE PIONEER ELECTRICAL WEEKLY OF AMERICA.

VOL. XL. No. 21. NEW YORK, SATURDAY, MAY 24, 1902. ISSUED WEEKLY

ELECTRICAL REVIEW

PARK ROW BUILDING

13-21 PARK ROW - - NEW YORK

P. O. BOX 339

BY THE

ELECTRICAL REVIEW PUBLISHING COMPANY

CHARLES W. PRICE
PRESIDENT AND TREASURER

STEPHEN H. GODDARD
SECRETARY AND MANAGER

CHARLES T. CHILD
TECHNICAL EDITOR

RUSSELL HOWLAND
GENERAL REPRESENTATIVE

WESTERN OFFICE

40 DEARBORN STREET, CHICAGO

LONDON OFFICE

42 OLD BROAD STREET, LONDON, E. C.

REGISTERED CABLE ADDRESS

"ELECTVIEW" - - NEW YORK

TELEPHONE CALL, 21 "CORTLANDT"

(PRIVATE BRANCH EXCHANGE CONNECTING ALL DEPARTMENTS)

SUBSCRIPTIONS TO THE

ELECTRICAL REVIEW

One Year, United States and Canada - - - $3.00
One Year, Foreign Countries - - - - - 5.00
Single Copies, each - - - - - - - - 10

Copies can be supplied for only one year back at 25 cents each.

TO ADVERTISERS

CHANGES for advertisements should be in this office by Friday noon for the following week's issue.

NEW ADVERTISEMENTS should be in the office not later than Monday noon to ensure publication in that week's issue.

In this week's issue is presented the first instalment of the report of the convention of the National Electric Light Association, which has just closed its sittings at Cincinnati. This convention admirably maintained the high traditions of the past and was an occasion of very general interest. A number of the papers dealing with practical topics in electric lighting are also to be found on other pages, and will well repay more than casual reading.

SOME TELEGRAPHIC POSSIBILITIES.

It is very interesting to speculate upon what might happen if the telegraph companies in the United States should avail themselves of the opportunities that have been constantly presented to them for the last decade or two. While it is not perhaps just to say that the telegraph has had no development during that period, certainly it is conspicuous among all other branches of electrical engineering in its conservatism—to call it by no other name. To-day there are perfected several systems of rapid telegraphy and a number of methods for making better use of telegraph lines that remain practically untried and still in the condition of drawings and patent specifications. Nothing has been done for some time past to popularize telegraphy, to extend systems, or to make the telegraph cheaper and more available for the great mass of people who wish to use it. It is believed that recent changes in the personnel of one of the great telegraph companies will result in the vast improvement of telegraph service in this country.

While this service is, in the main, excellent to-day, it is not as good as it ought to be. On the average about one message a year is sent by every person living in the United States. Considering the great extent of our territory, the necessary delay in mails and the importance of swift communication, this figure should certainly be largely increased. Available methods of rapid telegraphy, for cheapening the transmission of telegrams and for making more efficient and larger use of the plant laid down in many places, are in existence and should be used. It is hoped that the near future will see the same variety of intelligent activity in telegraph service that long has been characteristic of electric lighting and railway corporations, and that new ideas may at least have a chance to prove their availability and their importance.

CONCERNING THE STUDY OF LIGHT CURRENT ENGINEERING.

The ambition of the average student in a technical school, studying electrical engineering, is to deal with large machines and apparatus and to handle many horsepower and kilowatts, and much energy in one form or another. To this average student electrical engineering is interesting and attractive, principally because it deals with superlative figures, and with large quantities of power and heavy outputs. There has been an almost flagrant neglect in our colleges and schools of another branch of electrical engineering, of very great importance, which deals with currents of the most extreme delicacy and with effects that almost approach the minimum limit of observation.

One of the most vitally important developments of electrical engineering has been the exploitation of the telephone. Very little popular attention has been called to the engineering features of this instrument and those required by its extension and application; but the fact remains that in investment represented, in volume of business done, in general public utility, and certainly in beauty of application, the telephone represents one of the most important branches of the whole of electrical engineering. The average course of electrical engineering in the average school seems to content itself with informing pupils regarding the basic laws of the telephone transmitter and receiver without going at all into the beautiful and complex detail of the applications of these instruments in practice.

Telephone engineering, as a career for the student, offers certainly as desirable openings as any other branch of the profession. The problems connected with the use of very small currents and with the successful operation of telephones are equally as interesting, and perhaps as important, as those connected with the transmission of great amounts of energy and

their utilization as motive power or light. The subject should certainly receive more attention than it has in the past, both on account of its intrinsic interest, and for the more sordid reason that the telephone industry offers an excellent opportunity for young engineers to make a comfortable living and perfect themselves in a remunerative profession.

X-RAYS IN PRACTICE.

Nothing better illustrates the way in which the public has become accustomed to the mysterious and the performance of the apparently impossible than the disappearance of the nine days' wonder that greeted the announcement of X-rays. These emanations were looked upon, with some justice, as the most mysterious manifestation of the witchcraft of science. For months the newspapers teemed with talk about them, some of it orthodox, while much more was built upon a purely imaginative basis. All this was during the period when X-rays were first proving their utility, and when a number of investigators were enthusiastically at work devising means for making the new radiations practically available in surgery and medicine.

It is interesting to note to-day, after the popular furor has quieted down, that the X-ray is accomplishing a work of beneficence in surgery and medicine quite as large as its most enthusiastic advocates hoped at the time of its introduction. Scarcely a hospital in the world is unprovided with radiographic apparatus, while a large proportion of physicians and surgeons in private practice have become adept in the use of these rays for diagnosis. Methods have been vastly perfected; practically instantaneous photographs can be taken of the smaller extremities, while radiographs through the larger portions of the body, once considered practically impossible, are now made in a few seconds. The penetration and power of tubes have been much improved, and the technique of X-ray examinations has been so developed as to make the indications obtained now of the utmost practical certainty and value. Further than this, the danger of burning or otherwise injuring the patient under examination has practically disappeared, while the rays have themselves been found of advantage in direct application for curative purposes. They are considered to-day a specific cure for certain refractory and hitherto intractable afflictions of the skin.

All this good work has been accomplished very quietly, and to-day the scientific curiosity of a few years ago is a part of the regular working equipment of the physician and surgeon. Operations of great delicacy and difficulty have been made easy and certain by their means, while their use in diagnosis has unquestionably resulted in the saving of thousands of lives.

WIRELESS TELEPHONY.

Ever since the first agitation of wireless telegraphy was begun there has been more or less talk, particularly in the newspapers, about telephoning without wires, and probably through this journalistic activity the general public has become more or less convinced that in time telephone systems will be operated without wires, as the same public is now entirely convinced that after a time all telegrams will be sent straight through the air to their destination without the necessity for cables, wires or poles.

The first experiments in wireless telephony were made about twenty-five years ago by Professor A. G. Bell, who succeeded in holding conversation at some distance over a beam of light. This experiment has often been repeated and, while the process has no commercial value, it is, of course, very interesting as exemplifying certain principles of science. In earlier installations of telephones great trouble and annoyance were experienced from a variety of wireless telephony commonly called "cross-talk" or induction, whereby conversations transferred themselves from one circuit to another without wires and without intention. Up to date these manifestations constitute the whole art of wireless telephony.

The methods in use for telegraphing without wires probably can not be applied to the telephone. At least, it is safe to say that nothing that has been developed up to now shows any promise of usefulness in this direction. The impulses or signals sent in telegraphing without wires are distinguished from one another merely by being longer or shorter; otherwise they are all alike. The impulses necessary in telephony are of extraordinary complexity and succeed each other with extreme rapidity. Even in order to conduct them by wires precautions of a most difficult and expensive character are necessary, in order that their quality and characteristics may be preserved. But even assuming for the moment that a system of wireless telephony could be devised the natural question suggests itself, of what earthly use would such a system be?

One of the principal advantages of the telephone is the fact that conversation can be maintained with absolute privacy and certainty with the desired correspondent. To ensure that conversation is held with the person desired has required the installation of telephone exchanges, into which run all the circuits from all the subscribers' instruments in the vicinity, and where proper connections are made between them upon orders to that effect given either verbally or by automatic machinery. Without the exchange the telephone would lose practically all its value, although it could be operated, of course, in a few situations where to-day private lines exist. As nothing indicating even a remote possibility of a wireless telephone exchange has ever been suggested, it seems reasonable to dismiss the whole subject as one of the vain imaginings of inventors of small knowledge, aided and abetted by the sensation-hungry newspaper press.

BRAKES.

The season for the active exploiting of electric railway lines is now approaching, and one of the questions that should exercise engineers and designers of such systems more than it appears to is that of brakes. The most elaborate mechanisms have been devised for the acceleration and moving of electric cars. Upon these there has been focused the skill and attention of almost a generation of engineers. While it is of course of vital importance to make cars move, it is of equal importance to stop them efficiently and promptly whenever it is desirable so to do.

In the evolution of the electric street

car the hand-brake, such as was devised in connection with the stage coach and modified to meet the demands of the horse car, was retained and is still retained in far too large a proportion of cases, notwithstanding the fact that the size, power and speed of cars have gained immensely. It is a fact to-day that the hand-brake is practically inadequate to the demands of the large, heavy and high-speed cars used in our larger cities.

Of power brakes two kinds, both very satisfactory, have been devised, one operating by electricity and the other by compressed air. On steam railways where heavy trains are operated at very high speeds the compressed air-brake has proved its efficiency and utility after more than a generation of use under all sorts and kinds of circumstances. The electric brake is newer, but apparently from the results of numerous tests made is equally efficient, while probably less expensive in installation and operation. One thing is certain, and that is the increasing size of electric cars absolutely makes exigent the application of a power brake of some kind in order to avoid accidents and to facilitate the prompt and satisfactory handling of the car or the train.

POLYPHASE MOTORS FOR ELECTRIC TRACTION.

At the Institute meeting last Tuesday night there were presented two very excellent papers relating to the subject of the use of polyphase motors for traction upon electric railways. In one of them particular attention was called to the fact that while polyphase traction has already proven in Europe its ability successfully to cope with the problems of traction, it has not in this country as yet been given a fair chance to show its capacities.

There is no doubt that in every case where it is proposed to equip a line of railroad with electrical motive power that all the conditions must be taken into account and carefully considered in all their bearings before a choice of the proper system can be made. There is no particular reason to assume in any case that any particular system is the only orthodox thing to use. Indeed, such an assumption is contrary to engineering common sense. Yet in this country, where we have examples of electric railways of every imaginable kind, the adherence of engineers and manufacturers to the five-hundred-volt, direct-current system has been little short of fanatical. In order to make use of this system it has been necessary in many cases to introduce alternating-current apparatus for the generation and transmission of the power required, and at substations to transform and convert the currents thus generated into the orthodox 500 volts. It has not seemed possible to conceive of the utilization directly of the alternating current. Perforce, it must be converted, and although this has involved very large expense in many cases, it has been done cheerfully enough by engineers who have thus brought their systems within fashionable lines.

It is true, of course, that manufacturing companies have not encouraged, to say the least, the use of alternating traction apparatus. The manufacturing electrical companies in this country have a plenty of work on hand from their standard patterns. The exploitation and introduction of a different kind of traction apparatus would cost much labor, time and money to them. It is certain for this reason that they will be glad to see well enough let alone, and perhaps in some measure this may account for the fact that we have not as yet seen even an experiment in this most promising direction. But neither the dictates of engineering fashion nor the narrowing confines of engineering orthodoxy, nor the natural enough desires of manufacturers to keep on making standard goods, can long stand in the way of an innovation that bears at least promise of a successful and profitable solution of many difficulties connected with a rapidly developing and important art.

HOUSE JOURNALS.

There appear now and then publications produced by manufacturing establishments and distributed through the particular field of their manufactures, primarily to advertise the wares of their proprietors. Such publications are termed house organs or house journals, and through their agency the manufacturers producing them attempt to reach their customers and to inform them of the excellence of their manufactured product. It is interesting to note that very few of these journals have persisted, and that only one or two of them have ever been published long, unless it may be those advertising gewgaws and trinkets which are sold by mail orders, generally in the rural districts.

There are several reasons why this form of advertising is unsatisfactory to those who practice it. In the first place, the house journal can not hope to compete in the interest and value of its non-advertising contents with the regular class and technical journals published in its field of activity. These papers, in the United States particularly, are almost universally conducted upon a high plane, employing as writers and contributors the best available talent and receiving careful and conscientious independent editorial care in all the details of their preparation. The house journal necessarily lacks the editorial skill and the ability to present valuable contributed matter which is possessed by the regular publications.

In addition to this, no house journal has yet succeeded in concealing its purpose, or in being more than a circular with incidental reading matter. Printing, paper, binding and mailing are expensive luxuries, and the padding of an advertising circular with extraneous information and stories, pictures and the like certainly serves no useful purposes at all commensurate with the additional cost involved. The whole proposition simmers down, if one considers it closely, to this: If a manufacturer wishes to advertise in a paper that will be read and preserved by its readers, he must of necessity go to the recognized journals dealing with his branch of activity, because he can not produce one so good for himself. If, on the other hand, he wishes to send his customers' advertisements by mail, he will do well to exclude the purely gratuitous and incidental reading matter which forms the bulk of the ordinary house journal and send them advertisements as such. There is no need to attempt to conceal a dignified advertisement of a good article. The best place, however, for its presentation is in the columns of the independent journal devoted to the industry of the advertiser.

THE THEORY OF ALTERNATING DYNAMO ELECTRIC MECHANISMS—LXIII.

BY W. ELWELL GOLDSBOROUGH.

In the case of commercial alternators, it may be safely said that the magnetic flux embraced by the field windings undergoes little, if any, variation within the time of a complete oscillation of the armature current.

Now, since the value of the flux passing through the field cores is not materially changed or varied during the time of one period while the load remains constant, and since the magnetizing component varies between a maximum and a minimum value during each period, the flux in the field cores must be permanently changed by an amount proportional to the average value of the magnetizing effect of the wattless component of the armature current. Further, from the symmetrical disposition of curve *f* of Fig. 158, the reaction set up by the magnetizing component of the armature current does not materially distort the flux distribution in the air-gap.

If n equals the number of turns in an armature coil, and I equals the virtual value of the armature current, and ϕ_0 equals the angle of lag of the current behind the total internal electro-motive force, and I_m equals the maximum value of the armature current, the magnetizing or wattless component of the armature current will produce an effect that is the equivalent of that exerted by a number of ampere-turns placed on a field spool equal to

$$\tfrac{1}{2}\, n\, I_m \sin \phi_0 \text{ ampere-turns.}$$

We are now in a position to somewhat more intelligently analyze the factors that go to make up what we have termed the synchronous reactance of an alternator armature. Any magnetism set up by the current flowing in the coils of an alternator which permeates the field windings goes to make up one of two important factors into which the synchronous reactance of an alternator armature may be divided. This flux, since it is linked with the magnetizing coils of the field winding, either increases or diminishes the total flux enclosed by the coils of the field winding, and may therefore be properly considered to constitute the reaction of the armature upon the fields. Necessarily, since these lines of force are due to the currents flowing in the armature coils, they set up in these armature coils a counter-electro-motive force of self-induction which acts at right angles to the effective electro-motive force developed in the armature windings that is in phase with the armature current.

In Fig. 159, this magnetism is designated by the vector M_0M_i, and the counter or reactance electro-motive force which it induces is represented by the vector C_iA_0.

Any line of force which is set up by the currents flowing in the coils of the armature of an alternator, which do not cut or become linked with the coils of the field winding, are a part of the flux due to the cross-magnetizing action of the armature currents, and are significant of a second coefficient of inductance of the armature winding.

By many writers this inductance is taken as being the only inductance of the armature coils, and the lines of force set up by the armature which link with the field coils are entirely credited to the armature reaction.

The effect of the inductance that is due to the local or cross-magnetizing lines of force set up by currents flowing in the armature conductors is to create a second counter-electro-motive force of self-induction that is also

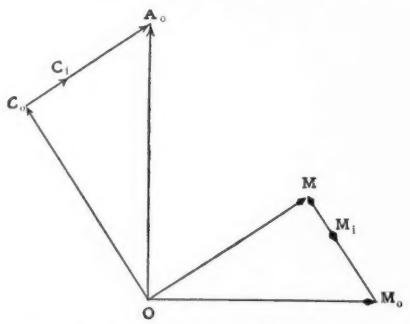


FIG. 159.—ALTERNATING MECHANISMS.

at right angles to the effective electro-motive force developed in the armature coils. In Fig. 159 it is represented by the electro-motive-force vector C_0C_i. The local or cross-magnetizing flux is represented by M_iM.

In dealing with the reactions which occur in an alternating-current armature, there are three of prime importance; the magnetizing action of the armature current upon the fields, the local inductance of the armature current and the ohmic drop in the armature winding. The magnetizing action of the armature current upon the fields and the local inductance of the armature current, since their combined influence is virtually that of producing a component magnetic field in the armature circuit, may be regarded as giving rise to an armature electro-motive force of inductance that acts at right angles to the current. This view is one which has dominated the discussion of the theory of the alternator up to this point. When, however, we take up the consideration of the reactions which occur in two and three-phase machines, it is no longer possible to merge these two inductance factors into one.

The Scientific Basis of Spark Telegraphy.*

In December, 1900, Dr. Slaby described his new method of wireless telegraphy and gave, in collaboration with Count Arco, a demonstration of long-distance transmission between Berlin, Charlottenburg and Schöneweide. This was the first practical solution of the "tuning" problem published. An account of the scientific basis of the method was then promised, and the following paper fulfills that promise. The exact mathematical method is not attempted, a simpler, more experimental method being chosen.

OSCILLATIONS IN STRAIGHT WIRES.

The following experiments were made to examine the production of the oscillations in straight wires: A bare copper wire of about ten metres (thirty-three feet) in lengths of 1 mm. thick was connected with one pole of an induction coil, stretched horizontally and insulated. The other pole of the coil was earthed or connected to a large capacity. When sparks pass the wire affords all the phenomena of rapidly alternating currents. As the mode of oscillation proves to be independent of the mode and frequency of sparking, it is permissible to speak of the proper period of the oscillations in the wire. The character of the oscillation may be determined by investigating at chosen points the mean current or potential there. In the first case a hot-wire instrument might be used; in the second case the spark-micrometer is found convenient. The following experiments were made with a spark-micrometer having a divided head, and measuring spark-lengths to 0.01 mm. Instead of metal spheres the micrometer possessed a blunt metal cone opposed to the ground end of a piece of arc carbon. Actual examination by this means of the wire arranged as above gave the curve in Fig. 1, where micrometer spark-length and distance from the end of the wire are plotted. A standing wave with potential loops at the ends and a relative node at the middle of the wire is thus detected. It is noteworthy that other oscillations possible in the straight wire, the so-called overtones, are so trifling as to be negligible practically. If the induction coil, however, be attached not to an end of the wire, but to some other chosen point, the same standing wave is found, but distorted (Fig. 2).

Thus any electric concussion starts an insulated wire into its own proper vibration.

* Abstract of a paper, *Elektrotechnische Zeitschrift*, No. 9. 1902. Translated by *Electrician* (London), April 25, 1902.

If two equal wires be arranged in line on either side of the induction coil, and connected respectively to each pole, as shown in Fig. 3, the compound system vibrates as a single wire made continuous by the spark-gap. To apply the spark-micrometer method the nearer of the two poles must be earthed, as otherwise the

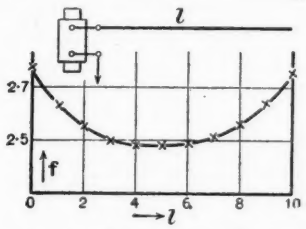


FIG. 1.—SPARK TELEGRAPHY.

almost direct spark of the secondary overwhelms that to be observed. For Fig. 3, wires each one metre (3.3 feet) long by 3 mm. diameter were used, the sparks passing between the rounded ends of the wires. The curve is, roughly, a sine curve, and shows that the harmonic law is followed.

An experiment was performed in which several incandescent lamps with straight filaments were connected end to end to build up a similar wire system to the last. The greatest luminosity occurred toward the centre. Micrometer measurements at the lamp terminals showed that there was ninety degrees phase difference between the potential and the current. The lamps indicated nodes of current at the ends and a current loop at the centre.

An insulated secondary wire was then stretched parallel to the system sketched in Fig. 2, and at some distance from it. If the secondary wire be at first longer than the primary, and be gradually shortened by cutting equal amounts from each end, then micrometer measurements at an end show first an increase and then a decrease of potential as the shortening proceeds. This is shown by Fig. 4. There is a determinate length where the effect is a maximum. This length might be called the resonance length. For this length the proper frequency of the secondary wire is in harmony with that of the primary exciting oscillation. This always occurs, whatever be the lengths of primary used. Moreover, the curves show that the wave-length of the oscillations in the secondary wire is, at the resonance length, the same as that in the primary.

The fact that the induced wave-length stands in such a simple relation to the wave-length in the sender may appear casual, and valid only for the selected diameter of the wires. To remove doubt, a brass tube of 51 mm. (two inches) diameter was constructed and compared with copper wire of 0.25 mm. diameter. Flat brass strips 51 mm. wide by one metre long were also used as primaries. In all cases the secondary was of copper wire 1 mm. diameter, and the resonating length of this was determined. The results are here tabulated:

Sender.	Length of sender.	Resonance length.	Percentage difference.
Wire of 0.25 mm. diam....	724 cm.	735 cm.	+ 1.5
Tube of 51 mm. diam	724 cm.	710 cm.	— 1.9
Strip, breadth vertical	724 cm.	710 cm.	— 1.9
Strip, breadth horizontal..	724 cm.	710 cm.	— 1.9

Thus, in spite of the extreme difference of the cross-sections of the primaries the resonance lengths differ from the pri-

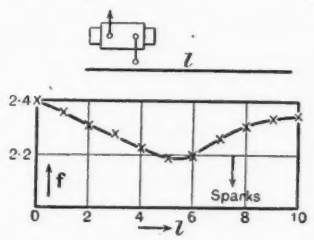


FIG. 2.—SPARK TELEGRAPHY.

maries less than two per cent, a deviation possible from mere experimental errors.

The foregoing experimental results admit of mathematical elucidation. Abraham's paper "On the Electric Oscillations on a Rod-Shaped Conductor," *Annalen der Physik*, 1898, p. 435, treats this question rigorously on the basis of Maxwell's equations, and contains the explanation. A more elementary treatment will here suffice. The problem is: Two equal wires, each length l, are arranged in a straight

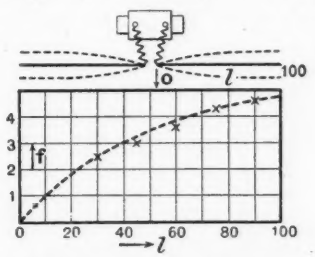


FIG. 3.—SPARK TELEGRAPHY.

line and connected with a source of high-potential difference. Their nearer, rounded ends are approximated so that a spark occurs when the charging potential reaches its highest value. Before discharge the charge is uniformly distributed, all parts of a single conductor having the same potential. As soon as discharge sets in, the current in the neighborhood of the spark-gap rises to a maximum, since the spark may be regarded as a self-inductionless conductor. At greater distances along the wire the current is smaller on account of the self-induction of the wire. Denoting by i the instantaneous value of the current at a distance x from the outer end of one conductor, by R_1 the resistance, L_1 the inductance, C_1 the capacity of unit length of the wire, we get the ordinary cable equation:

$$\frac{1}{C_1}\frac{d^2 i}{d x^2} = R^1 \frac{d i}{d t} + L_1 \frac{d^1 i}{d t^1}$$

The conditions of the problem lead to the equation:

$$i = a \cdot e^{-\frac{R_1}{2 L_1} t} \sin \frac{\pi}{2 l} x \cos p t$$

as a solution of the differential equation, a being a constant. Putting R, L and C for the resistance, inductance and capacity, respectively, of the whole length of wire, this becomes:

$$i = a\, e^{-\frac{R}{2L} t} \sin \frac{\pi}{2 l} x \cos \left(\pi \sqrt{\frac{1}{CL}}\, t \right)$$

approximately.

This shows that at each point of the wire the alternating current there has a different amplitude. The period T of the alternating current at each point is the same, and may be calculated from $T = \sqrt{CL}$ approximately.

Since the electrical disturbance travels along the wire with velocity $v = 3 \times 10^{10}$ cm. per second, the wave-length is given by

$$\lambda = v\, T = 2\, v \sqrt{CL}$$

Here C and L are in electromagnetic units. But

$$2\, v \sqrt{CL} = 2 \sqrt{(C\, v^2)\, L}$$

and $C\, v^2$ is the magnitude of the capacity expressed in electro-static units. Thus the simple relation $\lambda = 2 \sqrt{CL}$ may be

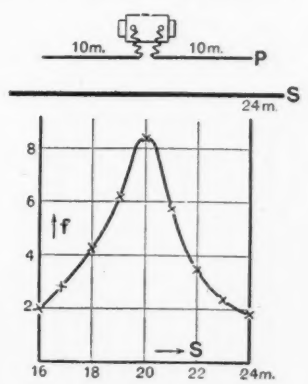


FIG. 4.—SPARK TELEGRAPHY.

used for calculation, C and L being both in centimetres.

For the inductance of a straight wire, length $2\,l$, radius r, Hertz used the formula

$$L = 4\, l \left\{ \log \frac{4\, l}{r} - 0.75 \right\}$$

which is deduced from Neumann's formula. Poincaré gives

$$L = 4\,l\left\{\log\frac{4\,l}{r} - 1\right\}$$

as more correct, as it allows for the "skin-effect." The difference is trifling in practice. Hertz's formula is preferred, since $0.75 = \log_e 2$ approximately, and his formula then becomes

$$L = 4\,l \log\frac{2\,l}{r}$$

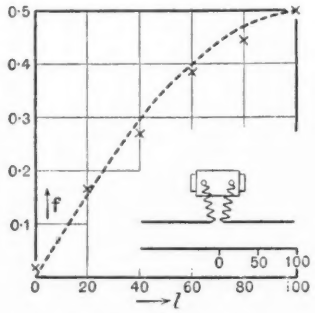


Fig. 5.—Spark Telegraphy.

The electrostatic capacity of a wire, length $2\,l$, radius r, neglecting the question of the proximity of the earth or other conducting masses, is

$$C = \frac{2\,l}{2\log\frac{2\,l}{r}}$$

Employing these values, then,

$$\lambda = 2\sqrt{CL} = 4\,l$$

The calculation thus confirms fully the experimental results. The mere length of the wire on which the oscillations exist determines their half wave-length.

The potential measured by the spark-micrometer is proportional to the maximum charge at the point to which it is applied. Let q_0 be the maximum charge per unit length of the wire at any point x, then

$$q_0 = \frac{\pi}{2\,l}\cos\frac{\pi}{2\,l}x\int_0^{\infty}\frac{\pi}{4}e^{-\frac{R}{2L}t}\cos\frac{\pi}{\sqrt{CL}}t\,.\,dt$$

The maximum charge thus follows the harmonic law, the highest value occurring at $x = 0$ and $x = 2\,l$, the least at $x = l$; that is, at the spark-gap. This is in complete accordance with the experimental result. Neglecting the damping, the equation reduces to

$$q_0 = a\,\frac{\sqrt{CL}}{2\,l}\cos\frac{\pi}{2\,l}x$$

Hence the whole quantity of electricity on the wire is

$$Q = \frac{a}{\pi}\sqrt{C}\,l$$

Further, still neglecting the damping,

$$i = a\sin\frac{\pi}{2\,l}x\,.\cos\frac{\pi}{\sqrt{CL}}t,$$

whence the average current along the length of the wire is

$$J = a\,.\,\frac{2}{\pi}$$

Hence,

$$\frac{J^2}{4} = \frac{Q^2}{CL}$$

or, putting $L' = \frac{L}{2}$ and $C' = \frac{C}{2}$ for the half-wire,

$$\frac{Q^2}{2\,C'} = \frac{J^2\,L'}{2}$$

that is, the electrostatic energy stored on the wire in charging becomes wholly current or electromagnetic energy, the oscillation consisting of alternating conversions of the one form of energy into the other. The energy of the charge gives rise to the so-called electrostatic effects transmitted through the surrounding medium, which are, however, not very far-reaching; for, at considerable distances

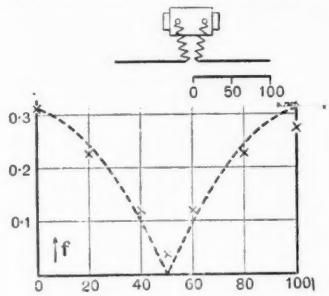


Fig. 6.—Spark Telegraphy.

from the primary, the effect is small, because the two halves of the wire system are at any moment oppositely charged.

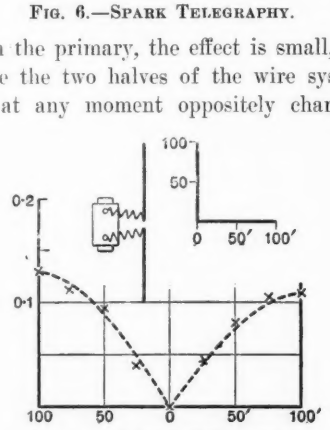


Fig. 7.—Spark Telegraphy.

The current energy gives rise to effects which follow the known electromagnetic laws. The alternation from one form of energy to the other is accompanied by losses, spoken of as the damping of the oscillations. In the above formulæ the exponential term expresses this loss. From that term the ratio of the amplitudes of two consecutive swings is seen to depend on $R\sqrt{\frac{C}{L}}$. The loss of energy is, then, threefold. First, heat is produced in the wire by its resistance, and also in the spark-gap; secondly, losses of charge occur, since the insulating power of the air is not infinite; and, thirdly, electromagnetic energy strays into space, according to Poynting's law. The last amount represents the useful work of the process from the point of view of spark telegraphy.

The conditions which bear on the efficiency of the receiving wire are next to be studied. Since the laws of electromagnetic induction hold as seen above, a parallel disposition of the conductors, sender and receiver must be best. Also, the experiments already described show that the maximum effect occurs when the receiver has the same length as the sender. The following experiments were arranged to investigate the mode of oscillation in different arrangements and figures of the secondary.

The sender consisted of two polished solid brass rods, 3 mm. in diameter and each one metre long. They were screwed into an ebonite vessel filled with petroleum in which the spark occurred. Their outer ends were insulated by glass supports. An induction coil of 15-cm. (six-inch) spark was used. A brass rod of equal thickness, resting insulated on glass supports, served as receiver.

The receiver, two metres long, was placed one metre distant, parallel to the sender. Spark-micrometer measurements were made while the sender was in operation. Fig. 5 represents these measurements. The curve is a quadrant of a sine curve with a node of potential at the middle of the rod, the rod thus vibrating as a half wave-length.

The rod was shortened to one-half. The result is plotted in Fig. 6, which shows that the rod is the half wave-length of a vibration of double the frequency of that of the former arrangement, corresponding to the first overtone of the primary. It is noteworthy that the maximum potential at the ends reaches only about half the value indicated in Fig. 5.

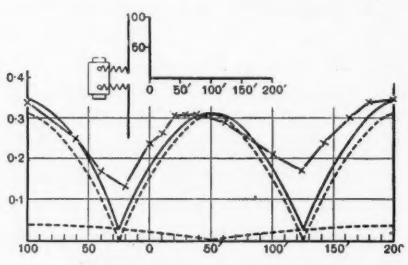


Fig. 8.—Spark Telegraphy.

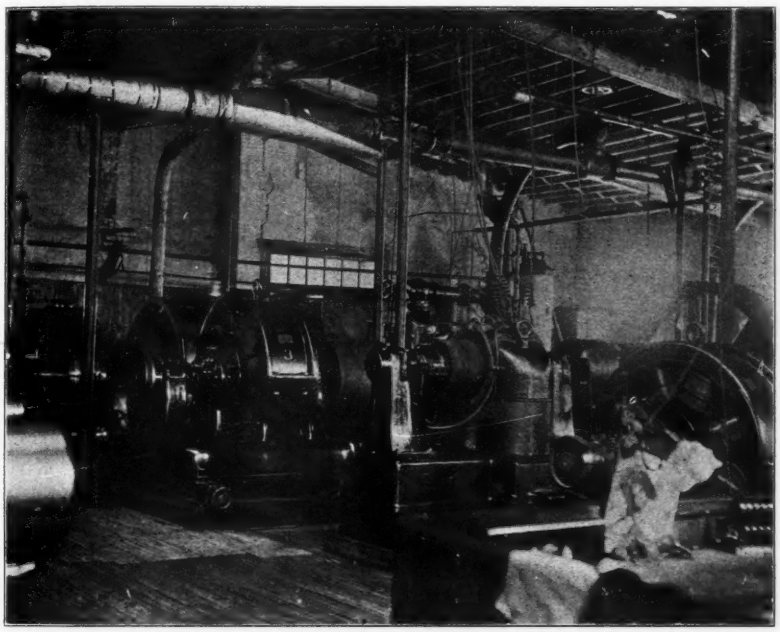
Another metre of rod placed in line with, but not touching the rod in the last case, assumed a similar state of vibration without disturbing the oscillation in the first metre.

(To be continued.)

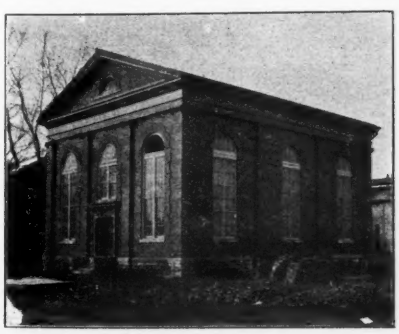
Some Typical Western Electric Lighting Plants.

A Glance at Some of the Installations under the Supervision of Mr. Henry L. Doherty, Past-President of the National Electric Light Association.

THE CONDITIONS surrounding the establishing of electric light and power installations in the western states are in many respects entirely different from those which surround similar enterprises in the East. The West has grown quickly, and its cities, finding abundant room, have expanded territorially and cover in proportion to their population very large areas. Coal is relatively expensive, while in many situations water power is abundant and relatively low in cost. In practically all the cities of the great central and western divisions of the United States urban growth has been so rapid that it has been hard for public service utilities of any character to keep pace with the rapidity of its extension. Consequently in many places engineering adaptations of an exceedingly interesting character have necessarily been resorted to, and often with the most satisfactory effect. In many of these cities, also, the alternating current is used throughout for all purposes, principally on account of the large areas to be covered from a single centre of generation and from the lack of density of population in urban districts.

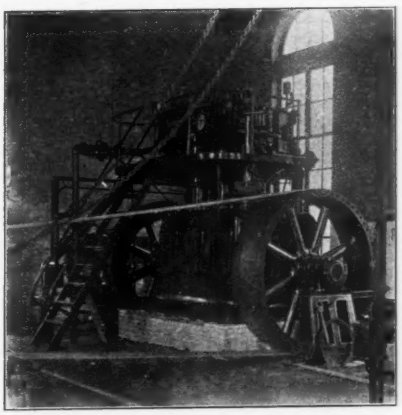


VIEW IN THE MADISON, WIS., STEAM STATION.

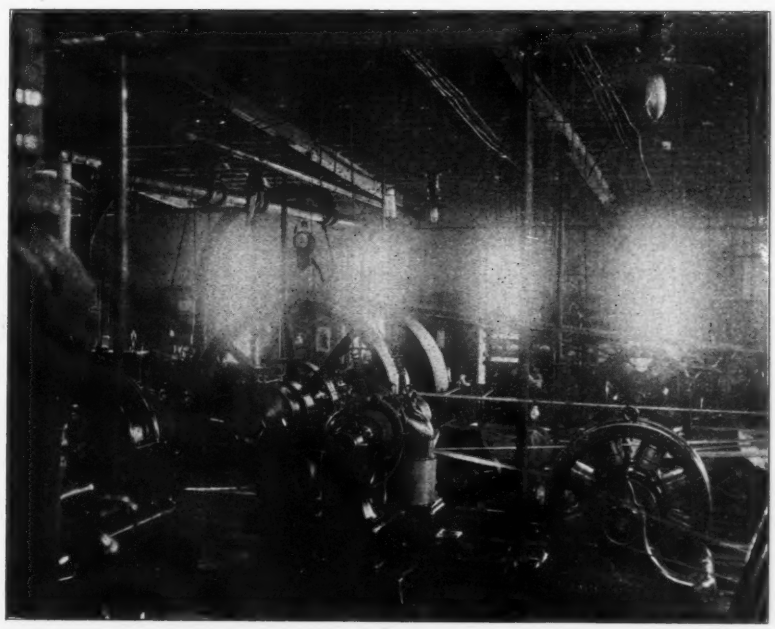


EXTERIOR OF MADISON, WIS., GAS ENGINE STATION.

The following brief descriptions of plants set forth some of the details of what may be regarded as purely typical installations. All of those described in this article have been developed by Mr. Henry L. Doherty, late president of the National Electric Light Association, and an officer in all of these companies. A considerable proportion of them have also

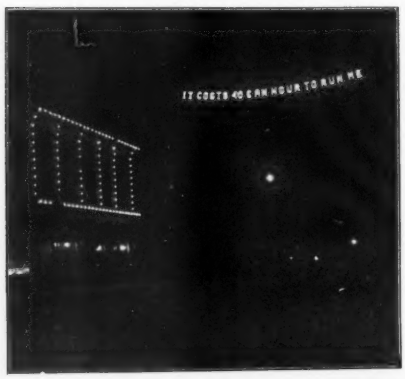


INTERIOR OF MADISON, WIS., GAS ENGINE STATION.

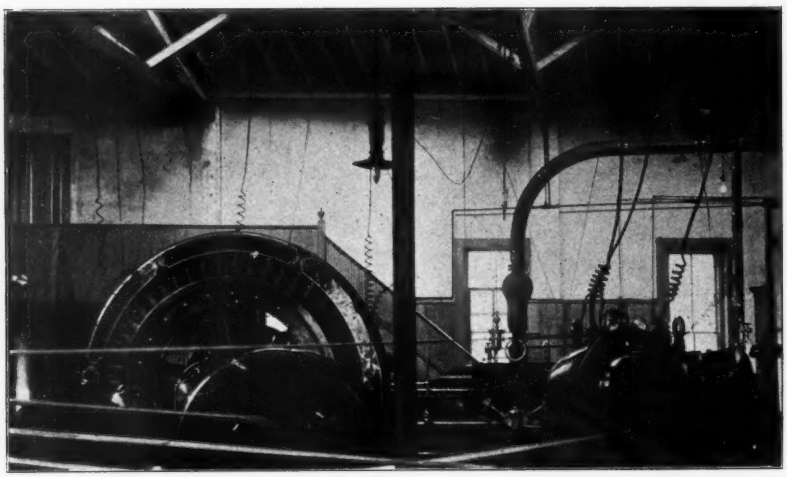


VIEW IN THE MADISON, WIS., STEAM STATION.

been financed by Mr. Emerson McMillin, of New York, who has had, perhaps, as large a share as any other one man in developing the electrical activities and interests of the central and western parts of the country.



How the Madison, Wis., Station Advertises Electric Signs.

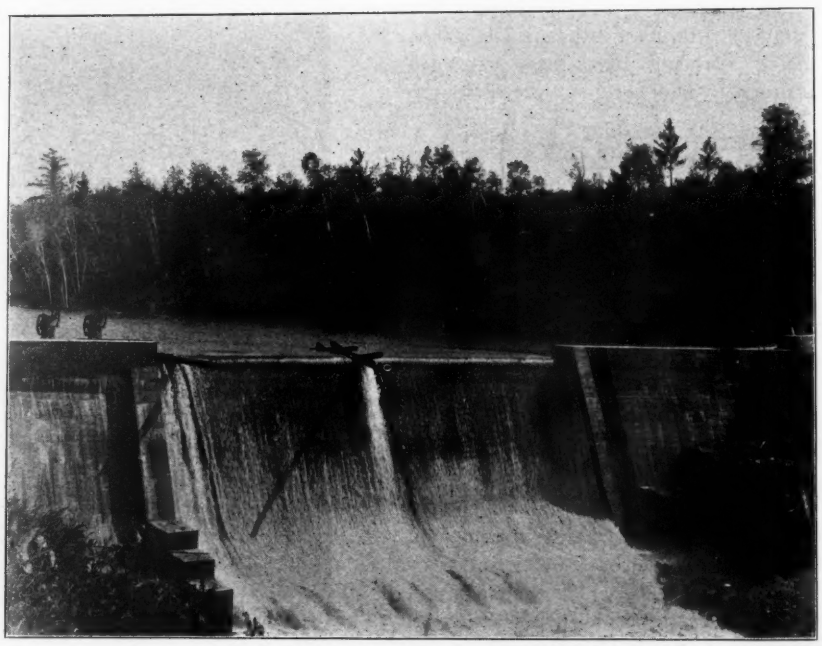


View in the Steam Station at Madison, Wis.

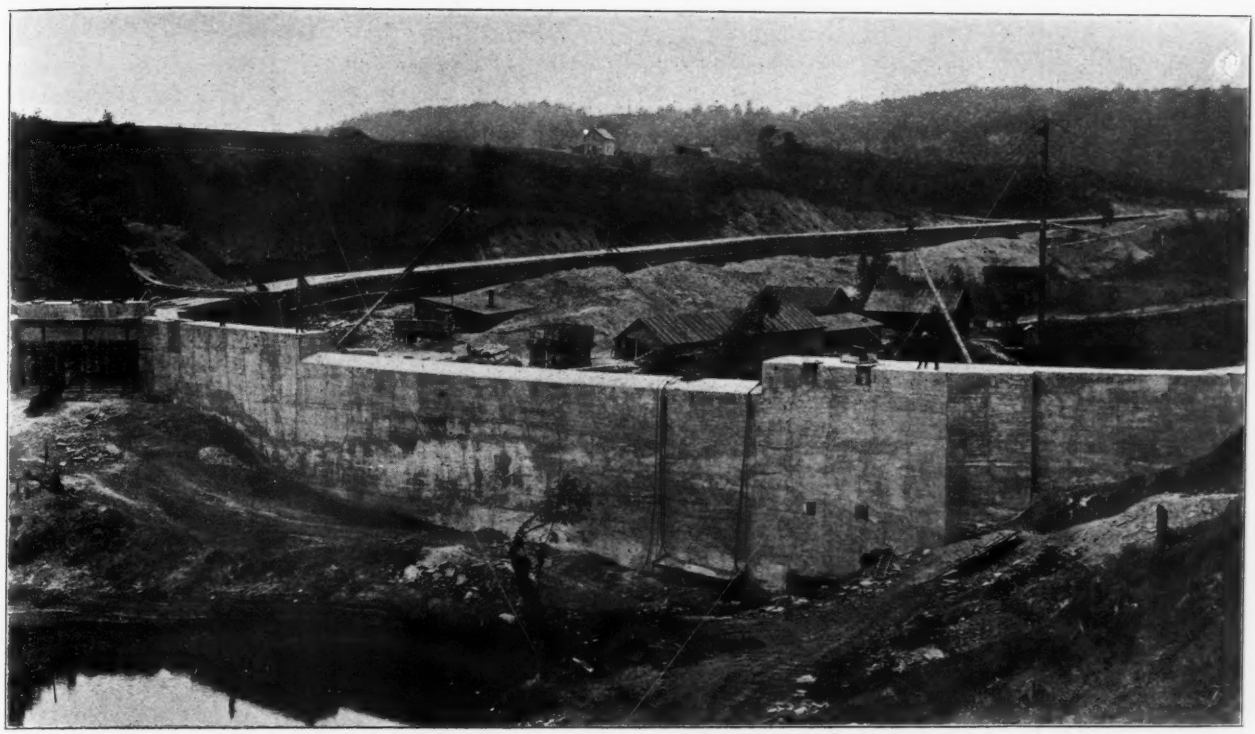
At Madison, Wis., which has some 20,000 population, the electric light plant has 34,000 sixteen-candle incandescent lamps wired up and in service. No less than eleven-fourteenths of all the power used in that city is supplied from the electric light station. The Madison Gas and Electric Company, which is the name of the operating corporation, has not only a steam station, the interior of which is well illustrated in the accompanying engravings, but also a very interesting substation operated by a gas engine. Mr. Doherty writes that it is the intention of the company eventually to extend the gas-engine service so that finally all of the electric current generated at Madison will be by means of gas engines. Two of the illustrations give an exterior and interior view of the gas-engine station. The engine is of the Westinghouse triple-cylinder type belted to the dynamos. In the steam station may be noticed the usual combination of apparatus to be found in many parts of the West where stations have grown with great rapidity and one type and another of machinery has been installed to take care of the constantly increasing demands of the connected load.

The plant of the St. Croix Water Power Company, which is owned by the American Light and Traction Company, of St. Paul, is an exceedingly interesting installation. The St. Croix water-power plant is located on the Apple River, and was built under contract by Mr. Charles N. King, under the special direction of Mr. Henry Floy as engineer in charge. This plant supplies current in the city of St. Paul for the use of the St. Paul Gaslight Company and the St. Paul Edison Company. In the city of St. Paul the gaslight company still maintains two steam stations which are used as relay plants, and also to do district heating by means of exhaust steam piped about to the various customers' premises. The old steam station of the St. Paul Edison Company has been abandoned as an operating station, although it is still maintained in working order so as to be useful in case a breakdown occurs. Mr. Doherty is the chief engineer and general manager of the American Light and Traction Company which now owns these properties.

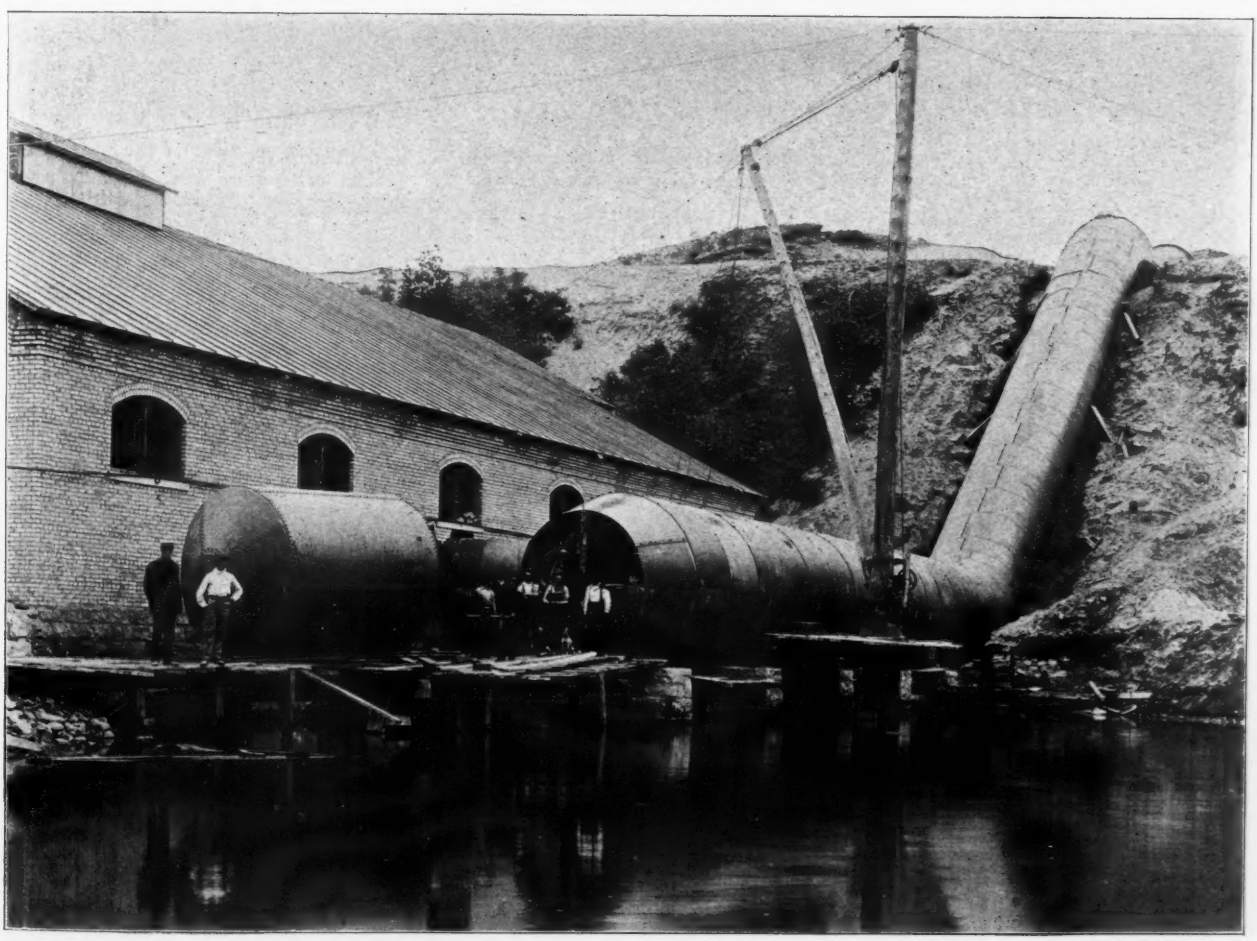
Some of the accompanying illustrations show some details of the dam and station at the Apple River. The plant is located twenty-seven miles east of St. Paul at a point where a natural fall of about thirty feet takes place in the Apple River. Above the fall a dam was built to a height of forty-seven feet, giving, with a slight drop in the river below the dam, a total head of eighty-two feet. The river is fed from twenty-five lakes and innumerable springs in northwestern Wisconsin, and is consequently extremely steady and uniform in its flow throughout the year. The minimum power of the developed fall is 2,000 horse-power, while the average is about twice that amount. The hydraulic developments consist of a dam resting on concrete foundations and having a masonry core covered with concrete facings. The flume begins at the south end of the dam and runs westwardly for 1,550 feet to a gate, whence a steel penstock twelve feet in diameter descends to the power-house. The flume is built entirely of wood caulked with oakum and braced by vertical and horizontal tierods. The generating station is a fireproof brick and iron building, 140 by 50



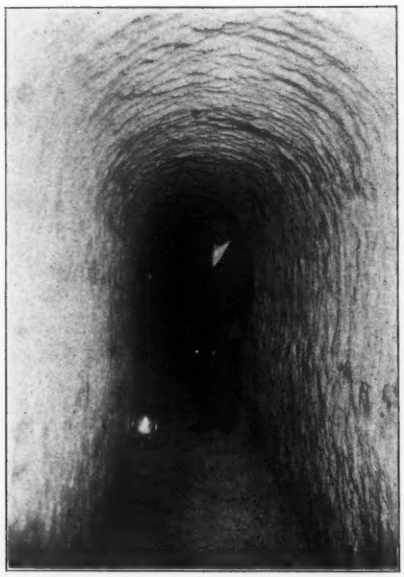
Spillway of the St. Croix Dam.



VIEW OF THE ST. CROIX DAM AND FLUME SHORTLY BEFORE COMPLETION.



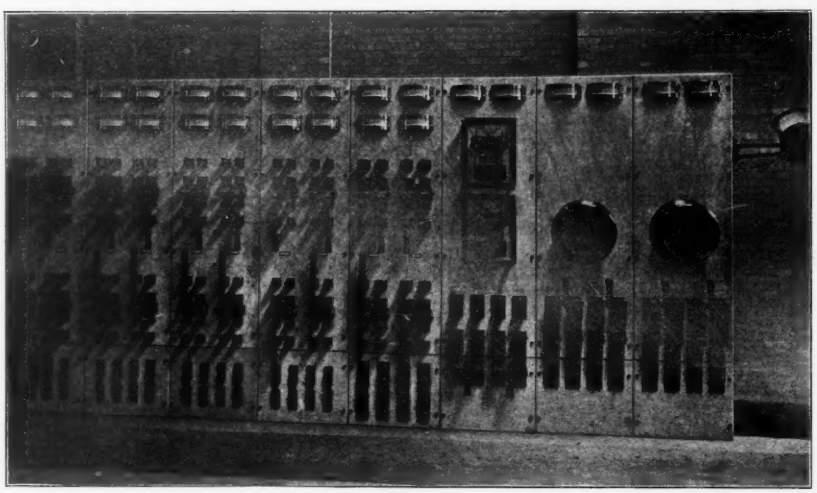
A VIEW OF THE ST. CROIX POWER-HOUSE AND PENSTOCK BEFORE COMPLETION.



Wire Tunnel at St. Paul Station.

voltage drop in the line. A group of air-blast transformers, each of 500 kilowatts capacity, steps up the generated current to 25,000 volts. The dynamos and other electrical apparatus were supplied by the General Electric Company with the exception of the switchboards and smaller auxiliaries. From this plant two three-

The Offices of the Denver (Col.) Gas and Electric Company.

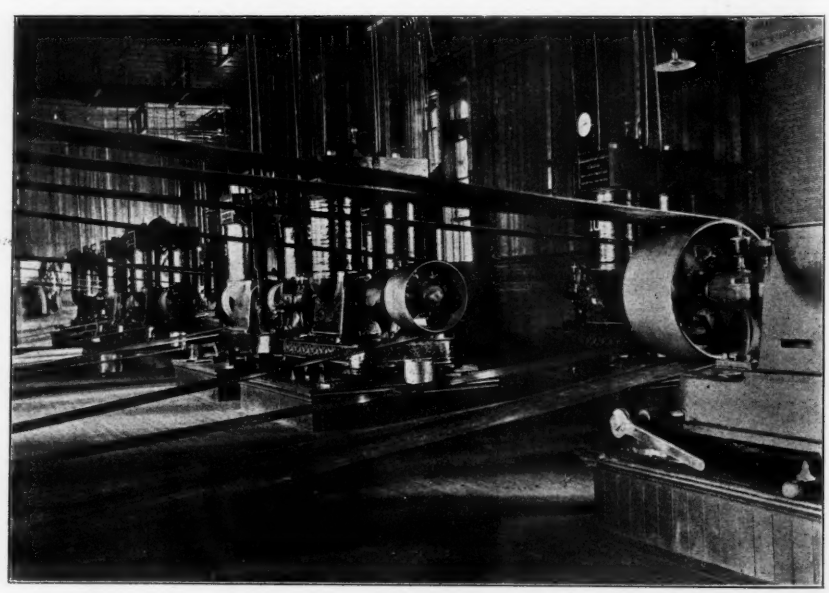


Direct-Current Switchboard in the St. Paul Receiving Substation.

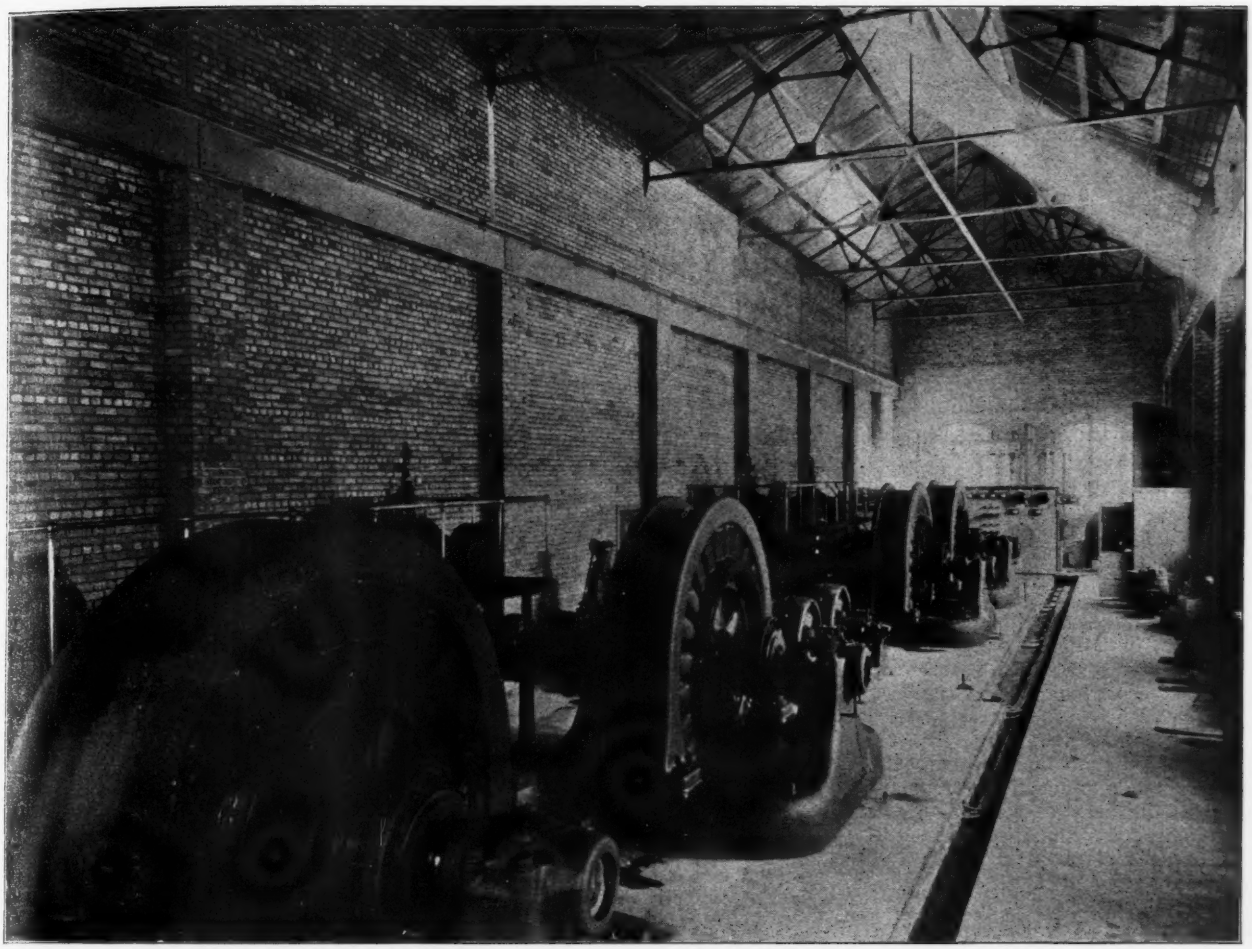
wire circuits, each consisting of twenty-four and one-half miles of bare copper wire overhead line and three miles of underground cables, connect the station with the substation in St. Paul. Both the overhead circuits are carried on a single line of wooden poles thirty feet high. The conductors are of No. 2 gauge medium hard-drawn copper wire carried on glass insulators, each of which is seven inches in diameter. In crossing the St. Croix River, which is about half a mile wide, advantage is taken of the railway bridge, long oak pieces being fitted between the ties every fifty feet, these pieces projecting twenty feet beyond the edge of the bridge. On these the six wires are carried in a horizontal plane, those of each circuit being spiralled three times in the length

feet, divided longitudinally by a brick wall which separates the wheel room from the dynamo room. In the wheel room are four main sets of Victor turbine wheels, each set consisting of two thirty-six-inch horizontal shaft wheels, each shaft extending through the partition wall and being directly coupled to a 750-kilowatt generator. In addition, there are two exciter wheels, each coupled to a thirty-kilowatt direct-current generator for supplying exciting current. Governors of the Giessler pattern are used.

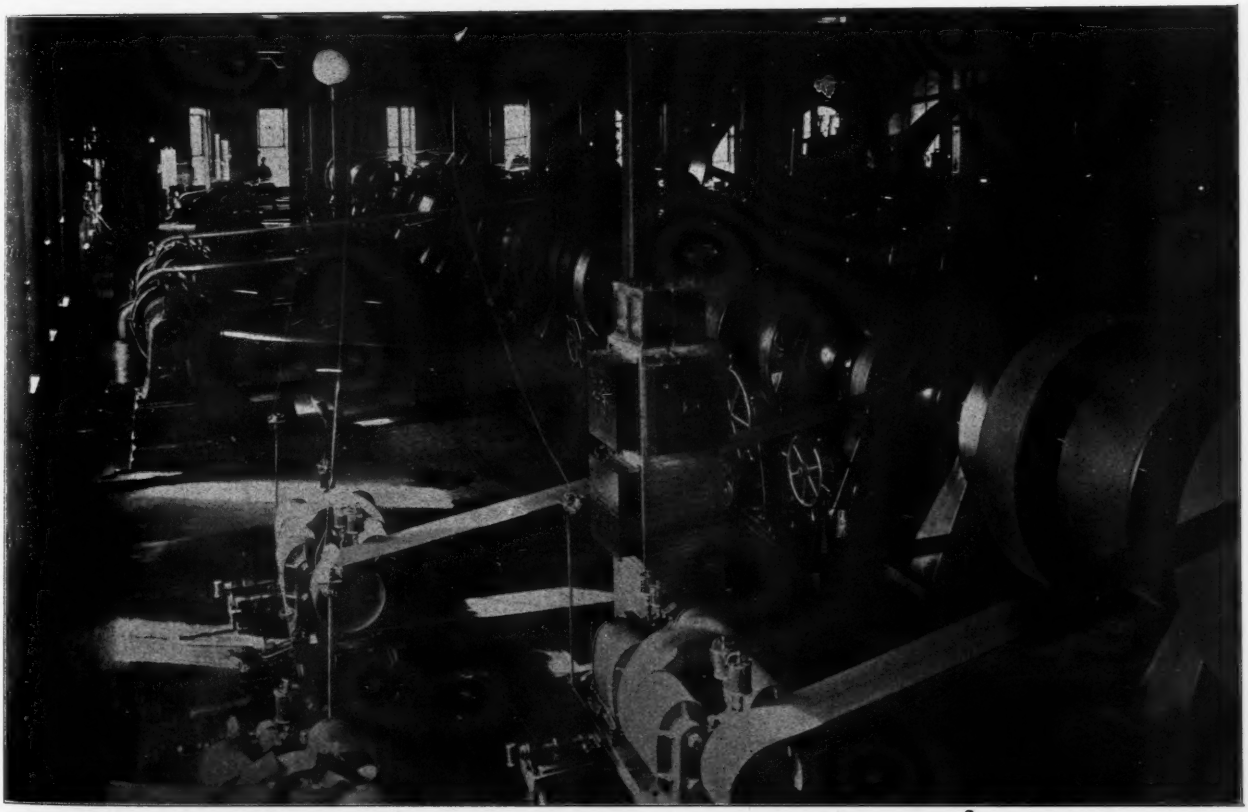
The dynamos are of the revolving armature type, giving 800 volts at sixty cycles when running at 300 revolutions per minute. The switchboard is of the usual type, but contains several instruments of particular interest. One of these is a potential indicator which enables the operators at the station to determine the voltage at St. Paul substation without regard to the power-factor of the load or the



Interior View of Old Cedar Street (St. Paul) Edison Plant, Now Maintained as an Emergency Reserve.



VIEW OF DYNAMO ROOM (PARTLY COMPLETED) OF THE ST. CROIX STATION.



A VIEW IN THE SAN ANTONIO (TEXAS) GAS AND ELECTRIC COMPANY'S STATION.

of the bridge. The underground cables are of the three-conductor lead-covered type and are laid in McRoy vitrified clay conduits. The two sets of cables were made respectively by the National Conduit Cable Company and the Standard Underground Cable Company, and are respectively of paper and rubber insulation. It is interesting to note that these cables, which were the first to be subjected to the high tension of 25,000 volts, have worked with great success and satisfaction. In St. Paul the current is received in a fireproof substation building in which the step-down transformers and high-tension switches are situated in the basement, connected by a tunnel with the street conduits. The main floor contains six 200-kilowatt rotary converters and a large space for a storage battery. From this substation current is distributed to the three-wire direct-current network formerly maintained from the steam station of the St. Paul Edison Company. This plant, which is illustrated in one of the smaller engravings, is still maintained as a reserve installation.

At San Antonio, Tex., the American Light and Traction Company also maintains the plant of the San Antonio Gas and Electric Company which operates both electric light and railway service. The accompanying illustration shows a view in the power station of this company.

In Denver, Col., the Denver Gas and Electric Company is operating 135,000 lamps and 3,000 horse-power in connected motors. This is one of the finest electric light properties in the western states.

Nickel-Steel Alloy.

The remarkable freedom from variation under extreme temperature changes makes nickel-steel valuable for pendulum rods of high-grade clocks. Nickel-steel also has the valuable property of resisting oxidation or rust to a remarkable degree, as it may be exposed for weeks to conditions which would ordinarily coat iron or steel heavily with rust without showing more than minute specks of corrosion. Railway rails having an alloy of thirty-six per cent nickel would require practically no allowance for expansion between ends, since the total expansion of a mile of track from twenty degrees below zero to 100 degrees Fahrenheit would be only about three inches.

A standard type of electric transformer oil has a paraffin base, is lighter than ordinary cylinder oil and heavier than ordinary machine oil. About thirty degrees Baume is a standard specific gravity. It must have a high flash and fire temperature, low evaporation and be a good insulator. A standard flash test would be about 336 degrees Fahrenheit, fire test 400 degrees Fahrenheit. Such an oil is not at all like kerosene.

The Union Traction Company's Test by Purdue University Students.

The students of the junior and senior classes of the school of electrical engineering of Purdue University, La Fayette, Ind., with the cooperation of the officials of the company, have completed a very successful and comprehensive test of the entire system of the Union Traction Company.

The Union Traction Company is located in the gas belt of Indiana, with central generating station and general offices at Anderson, Ind. The company serves a population of 350,000 inhabitants, if Indianapolis at one terminal may be counted, and operates over 109 miles of interurban and fifty-four miles of local tracks.

The credit for the admirable arrangements, so perfectly carried out, is due to Professor W. E. Goldsborough, director of the school of electrical engineering of Purdue University; Mr. A. S. Richey, electrical engineer of the Union Traction Company, and Mr. Percival Fansler, a graduate student of Purdue University.

The disposition of sixty-four students, for a period of seventy hours, more or less unfamiliar with the duties about to be performed, scattered over a road 109 miles in length, each desirous of gaining all the experience possible, all without confusion, is quite a feat of generalship in itself.

The preliminary work, such as making schedules and placing the meters properly, was done principally by ten senior students who were preparing theses upon different railway topics. They spent three weeks prior to the arrival of the main body of students in making preliminary and special tests. The senior students worked in pairs, thereby making five divisions of the test, into which division each student of the main body had eight hours' duty. For instance, after working eight hours in the boiler and steam rooms, after eight hours rest, he was assigned to duty in the generating room, then to substation duty, and finally car duty.

Mr. D. H. Wilson and Mr. O. C. Stein supervised the test of the boilers and steam engines of the generating station. The coal was weighed, water measured quantitatively, and the temperature taken at stated intervals; in fact, there were no signs of holiday regalia. The separators, the engine indicators and gauges required constant attention from these two men, as each shift brought them new men to break in.

Messrs. Reid and Gregg had charge of the generating station at Anderson, watching particularly the exact time, and giving signals for simultaneous readings throughout the main station. The substation and car men had their watches carefully inspected, and it is at least presumed that a simultaneous reading of the entire system of meters was generally obtained. The many details of this part of the work were carefully handled.

Messrs. Hollingsworth and Dinsmore had charge of the substation work. With substations at Anderson, Ingalls, Laurence, Daleville, Muncie, Alexandria, Fairmount, Elwood and Marion, of nearly 4,000 kilowatts capacity, the continual change of shifts, and the responsibility of seeing that each man was at his proper post, it is safe to say these two students covered many miles in seventy hours.

There was one particular duty at several of these stations which required twenty-two hours each day of eternal vigilance. That was the duty of watching the ammeter of the booster and battery circuit, and throwing a switch backward and forward as the needle passed 0 to the right or to the left. To the right of 0 the needle showed that current was flowing from the battery out to the line, while to the left 0 the ammeter needle indicated that the battery was being charged.

Two ammeters were placed with current coils in this circuit, while the pressure coils were connected across the terminals dependent upon the position of the switch. If needle was to left of 0, the switch connected the pressure coils of one meter, and it recorded thereby the total charging current. If the needle was to right of 0, the thrown switch disconnected pressure coils of the charging meter and connected the pressure coils of the meter, which recorded the total discharge. One familiar with station work can readily realize that the needle of the booster and battery ammeter did not have decided positive or negative positions. It can easily be seen what a smooth regulation effect the battery and booster circuits of the substations have upon the central station load.

Messrs. Zapp and Dostal had charge of car tests. This duty was an alluring one to most of the boys, sitting in the vestibule of a swiftly moving car and taking readings every fifteen minutes, and additional wattmeter readings of the beginning and end of each trip. The time and number of stops were also recorded. Special tests were made before the regular tests, so that a broad gauged estimate of car action may be found.

Messrs. Hofft and Peticolas had charge of the efficiency of the power distributing circuits, including high and low-tension

feeders and track. One mode of testing was "a polyphase recording wattmeter will be placed in the low-tension side of the set of transformers supplying any two substations, and one in the low-tension side of each of the step-down transformers fed from that line. The difference of the two readings, minus the losses in the three transformers, as determined, will give the loss in the high-tension lines in question."

The position of the observers may be better understood from the following schedule. The shifts were of eight hours' duration, and no student repeated the work of his preceding shift. So complete was the schedule that any student at any hour of the test could be located. There were thirty-two divisions of the work, requiring two men working eight hours alternately. The divisions were as follows:

(1) Coal log, boiler pressure, wattmeter data, temperature.

(2) Chief of engine room. Time announcer.

(3) Extra.

(4) Separators.

(5) Indicators on engine No. 1.

(6) Indicators on engine No. 2.

(7) Speed and engine gauges.

(8) Generator output.

(9) Load panel.

(10) Bus-bar voltage. Exciter voltage and current. Rotary electro-motive forces.

(11) Rotary ammeters.

(12) Battery switch.

(13) Direct-current ammeters, voltmeters and wattmeters—Daleville.

(14) Battery switch at Daleville.

(15 and 16) Same as Nos. 13 and 14, at Muncie.

(17 and 18) Same as Nos. 13 and 14, at Laurence.

(19 and 20) Same as Nos. 13 and 14, at Ingalls.

(21) Same as No. 13, at Elwood.

(22) Same as No. 13, at Alexandria.

(23) Same as No. 13, at Fairmount.

(24) Same as No. 13, at Marion.

(25, 26, 27, 28, 29 and 30) Local interurban cars, ammeter, voltmeter, wattmeter.

(31 and 32) Limited interurban cars, voltmeter, wattmeter.

This list only partially covers the duties of the respective stations.

The main body of the students left La Fayette, Wednesday, April 16, on a "Big Four" special, in charge of Professor Goldsborough. An interurban car conveyed the boys from Indianapolis to Anderson, Ind. The special gave the boys some idea of the high speed attained by electric traction. Some disappointment was felt because a "Big Four" passenger train did not happen along to try the racing powers of the special. The freights are not able to compete in the question of speed at any time. Tests of speed showed a maximum of fifty-eight miles an hour and that forty-eight miles an hour could be maintained.

Arriving at Anderson, the students received their schedules and instructions for the work following. Those who drew substation work on the first shift were compelled to leave Anderson at 9 P. M. for the various places, to be ready for the opening tests the following morning. At four o'clock simultaneous readings at each quarter hour began and did not cease till Sunday, 2 A. M. The ones who went to the substations at first suffered some inconvenience as to sleeping quarters and inability to get food, but the kindness of the substation man gave them relief from hunger until relieved at twelve o'clock. However, a satisfactory commissary department was soon organized and no more cases of hunger were reported.

There were no serious accidents. Outside of a few trivial cases of burns from steam, hot water and electricity, one man fell into a coal hopper, but, fortunately, the machinery was not running.

The presence of recording meters in the cars had a good effect upon the motormen. They were very careful about using heavy starting currents. They were uniformly kind and courteous to the students. Likewise were the station men helpful in every way.

The test was completed at two o'clock Sunday morning, and, after a few hours of rest, a special car conveyed the crowd to Indianapolis. From thence they arrived home on the "Big Four" Sunday noon.

For three weeks before the main body of the students arrived the ten senior theses men had been making preparations and running special tests.

In the preliminary, regular and after tests of steam boilers and engines, Mr. Wilson and Mr. Stein necessarily had work of much difficulty. They were compelled to uncouple the Holly system, put in elbows, to get condensation results. This was accomplished with steam units in full operation. The Venturi meters had been electroplated, and this necessitated calibration before and after the tests.

During the general test there were no means to find out the amount of fuel and water consumed by the numerous auxiliary engines. After the test these were coupled to one boiler and results taken, which were deducted for the general results.

Messrs. Hollingsworth and Dinsmore made some special substation tests with a view of predetermining the general results. They took direct-current readings every thirty seconds, and from 5 to 7 P. M. took fifteen-second readings. By a special device the fluctuations of the booster and battery ammeter were recorded.

A large induction coil secondary terminal was connected to the ammeter needle by a light contact which allowed the needle to slide freely. The needle was lengthened by an additional inch, which came into as close contact as free motion would permit, to a sheet of tin covered with white paper. The sheet of tin was connected to the other terminal of the secondary coil. The tin sheet was moved by clockwork through twenty-minute cycles. The discharges from the induction coil easily leaped the space between the horizontally moving needle point and the vertically moving tin plate, and recorded a continuous line of spark punctures upon the white paper. Excellent results were obtained, and the results obtained will serve as an excellent check upon the fifteen-minute readings.

A special car test was made by Messrs. Zapp and Dostal, and Mr. Renshaw, of the Westinghouse company. For a speed indicator, a magneto auto-sparker was belted to a pulley on the shaft, with a voltmeter, reading to fifteen volts, in circuit. A reading of one volt represented five miles per hour speed.

On the car with two motors, a voltmeter, ammeter and wattmeter were placed in the circuit of one motor. This gave the readings of the motors in series, and determined whether the motors were running in series or parallel.

A wattmeter was put in one motor field, the current and voltage measured, to get the total energy in the fields. Knowing the time, the square root of the mean square current was determined, and the average heating effect found.

They found the resistance of the field and armature by the fall of potential method, and temperature by thermometer. Special tests on the cars were made by taking readings of the energy supplied to the armature and fields, and of the speed in intervals of two and one-half seconds.

The record covers complete runs between principal stopping points along the road and gives complete running data for all the cars on all parts of the track.

Special prominence was given to means of determining acceleration and characteristics of the cars. About 11,000 readings were required for each run, and a number of runs were made with both two and four-motor cars.

The work represents the most exhaustive study of the behavior of heavy cars in service ever attempted.

Electrical Distribution of Power in a Cotton Mill.

At Columbia, S. C., which has recently become almost the centre of the cotton manufacturing industry of the United States, experiments already conducted in the electrical operation of cotton mill machinery led to the installation of electrical power distribution throughout the Olympia mill, a very large structure recently erected. The mill building is 553 feet long, 151 feet wide, and contains four floors and a basement. The engine and boiler rooms are in a separate structure at the rear of the main building, the engine room being 120 feet by 50 feet and the boiler room 140 feet by 40 feet in plan.

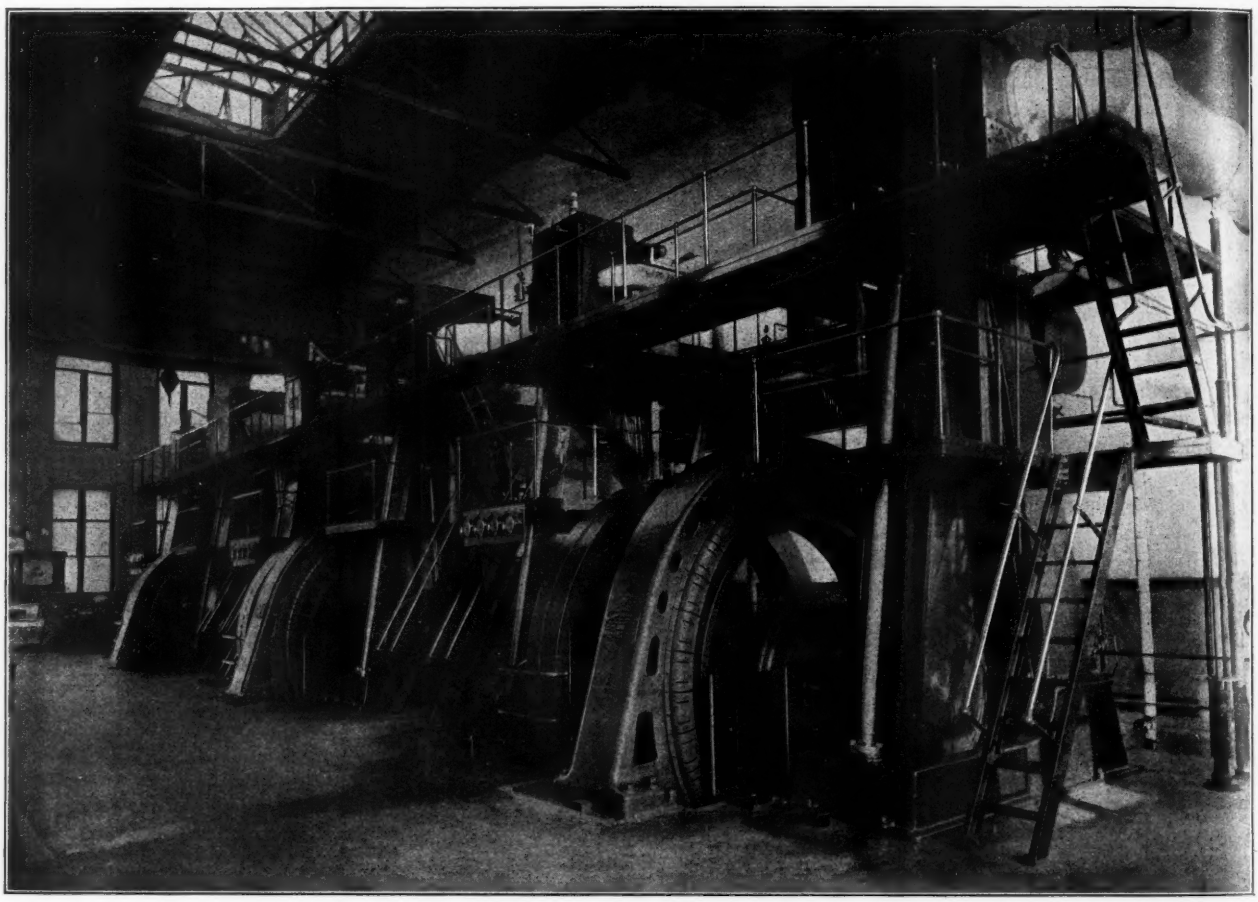
When the plans for the building were drawn estimates were taken on both methods of installation and the bids received for the electrical equipment installed were found to be considerably less than those for a belting and shafting plant. In addition to this the use of electricity enabled the cost of the mill building itself to be reduced by ten per cent on account of the absence of heavy transverse walls through the mill necessary for the head shafts of the belting and shafting system. Sixty-one per cent of the shafting cost and sixty-six per cent of the cost of belts and ropes were saved by the electrical installation.

The plant put down is sufficient to take care of the maximum demand of the mill, which is 3,600 horse-power, and also to supply current for the street railway and to light the town in which the mill is situated. The generating plant consists of the three McIntosh & Seymour engines, each normally rated at 1,600 horse-power, and capable of developing 2,000 horse-power, direct-coupled to alternating-current generators. The engines are of the vertical cross-compound condensing type and operate at an initial pressure of 165 pounds upon a consumption of not exceeding 12.7 pounds of steam per indicated horse-power-hour.

The dynamos deliver three-phase current at 600 volts in each phase. The exciter is a marine type vertical engine directly coupled to a seventy-five-kilowatt generator, this being used only in starting the plant or for emergencies. Ordinarily a seventy-five-kilowatt generator driven by an induction motor is used for excitation. The steam-driven exciter is also used at night or at other times when the main machines are out of service for running the lights in the mill. All of the electrical machinery was furnished by the General Electric Company.

The switchboard is nearly sixty feet long and contains twenty-one panels. Four of these are used for the street railway and for circuits to other mills. Two sets of bus-bars are used and every motor circuit is driven through a wattmeter which at once indicates any abnormal consumption of current.

The motor equipment of the mill consists of twenty-two induction motors of 150 horse-power, each running at 588 revolutions per minute on full load. These motors are suspended from the ceilings in the different departments of the mill, the most of them being placed in the middle of a twelve-foot length of shaft to which the motor shaft is directly coupled. The carding and weaving machines, however, which run at low speed require countershafting on this account. In addition to these motors six others of twenty horse-power are used, four of them for driving triplex power pumps for boiler feeding



ENGINE AND GENERATOR ROOM, OLYMPIA COTTON MILL, COLUMBIA, S. C.

and other purposes and two for running the elevators. A thirty-horse-power motor is installed to operate the slasher room, one of fifty-horse-power in the cloth-room, one of twenty-horse-power for the opener room, and one of the same size for the machine shop.

The steam plant consists of twelve Cahill water-tube boilers, each of 250 nominal horse-power. Each boiler has forty-eight square feet of grate surface and 2,533 square feet of heating surface. A very excellent quality of coal is used in firing, the ashes dropping into hoppers below the grates from which they are automatically delivered to cars. The entering air comes from a duct opening into the fan-room, whence the air is drawn through a flue surrounding the chimney so as to be considerably heated before it enters the grate. Fan draft is used throughout, two fans, each fourteen feet in diameter, being employed. Either of these is sufficient to run the boiler plant under normal conditions. The two fans discharge into a stack, ten feet in diameter, extending a short distance above the roof. The engines exhaust into a Knowles jet condenser or may exhaust free to the atmosphere whenever this is desirable.

The heating of the mills is accomplished by the indirect system, employing two fourteen-foot fans driven by electric motors.

ELECTROMAGNETIC OSCILLATIONS.*

BY RANKIN KENNEDY.

The fact that Mr. Marconi has detected these oscillations at a distance of 1,500 miles from their source on the globe puts a different complexion on the wave theory of propagation as applied to Marconi's results. The result of the actual experiment can not agree with the rectilinear propagation of the waves, the curvature of the globe seemingly having no effect, disposes of the straight-line propagation.

A lamp, however powerful, placed at Land's End could not throw a ray of light into a ship 1,500 miles off; neither could an oscillator send waves around the earth if these waves travel in a straight line, as light does. To me it seems that the effects are not due to ethereal waves traveling as light does, but to electrical oscillations set up in the earth itself considered as a whole sphere, insulated in space, and the same effects can be reproduced on a small scale on a large ball, or artificial earth, as it might be called.

Imagine a large globe suspended in space, practically a good conductor. Electrically the globe is nominally neutral, no difference of electrical potential existing between any portion; but let the electrical conditions be disturbed at any point—say that a sudden separation of electricity is made at the point A in Fig. 1—we know from common knowledge that the disturbance at A will be propagated all over the sphere, much in the same way as it would if the ball were of ivory and struck at A by another ball, every particle of the ball would be disturbed by the blow at A. Or consider the ball covered all over by a sea of water, and at A a submarine mine to be exploded, throwing up the water. A wave, or, rather, a series of waves, would be set up which would travel around the whole ball.

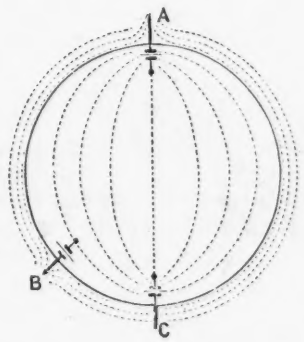


FIG. 1.—ELECTROMAGNETIC OSCILLATIONS.

In this view of the electromagnetic transmission of waves, we can imagine the rapid discharges at great potential at the point, A, agitating the whole electrical system of the earth, and that the earth is surrounded by an electrical atmosphere normally at rest and neutral, so that when disturbed at one point, this atmosphere vibrates or oscillates throughout its whole mass. And therefore there is no reason why communication between the antipodes, A and C, should not be practicable.

A large globe upon which a spark coil and a radial conductor can be laid at A, as in a Marconi installation, could be utilized as a working model. There can be no doubt that a rapid and high potential series of charges and discharges at A could be detected at B or C by a Branly tube or otherwise.

Considerations regarding results of experiments in laboratories, or even within a few miles of area, are not of much value in this matter. Marconi has applied the test to the whole earth, with the result that, so far as one can foresee, every wireless telegram is actually an effect of the surface charge of the earth as a whole, and not at all due to radiant energy traveling in space like a ray of light. However that may be, the subject now calls for very different treatment from that which it has hitherto received, not so much perhaps in the interest of wireless telegraphy as in the interest of fundamental knowledge.

Whether the earth as a whole is electrified as a ball with a charge upon it matters little; if it is electrified then the oscillator simply agitates this charge. Lord Kelvin forty years ago clearly proved the earth's surface to be charged, and suggested that the opposite charge might exist in the rarefied upper layer of the atmosphere; if this is so, then the gaseous dielectric is polarized vertically. He also pointed out that a very considerable electrification of the whole earth's surface could be effected by quite a small amount of charge. It is quite conceivable, then, that the earth's electrical equilibrium may be sufficiently disturbed by what seems a very feeble apparatus, compared with the dimensions of the globe, to operate the delicate detector on any part of its surface.

This theory, of course, still rests upon the wave transmission, but not upon straight-line action, the vibrations being propagated through the mass, only it is not the matter which vibrates, but the electrical charge upon it.

(To be concluded.)

Recent Experiments on Radium Rays.

A series of experiments upon the action of radium rays and also of the X-rays upon various dielectrics has been recently carried on by M. Curie. The liquid to be experimented with is placed in a metallic vessel in which is plunged a thin copper tube, and these two vessels act as electrodes. The outer vessel is kept at a constant potential by a storage battery, of which one pole is connected to earth. The tube is connected to an electrometer, and when the current traverses the liquid the electrometer is brought back to zero by an opposing potential and thus gives the means of measuring the current passing through the liquid. The copper tube connected to earth acts as a guard to prevent the current passing across the air. The radium compound is placed in a small glass bulb at the bottom of the inner tube, its rays acting upon the liquid after traversing the walls of the tube. In operating with X-rays these are sent up from below against the bottom of the vessel.

* From the London *Electrical Review*.

Electrical Patents

Mr. Thomas Duncan, a resident of Fort Wayne, Ind., on April 29 obtained fifty-seven patents for improvements he has invented in electric meters. He has transferred his entire interest in these patents to the Siemens & Halske Electric Company. While a great many of the patents are, of course, for different improvements along directly the same lines, and it is extremely difficult to select from so many, the most important, it is believed, the three herewith presented, will show the general trend of the inventions. One relates to improvements in induction motor meters. (Fig. 1.) The objects of this invention are to provide a meter of simple and economical construction adapted to measure with accuracy the energy consumed in inductive translating devices, such as arc lamps and motors, to provide in an induction motor meter an improved method of and means for securing a magnetic field in quadrature with the line pressure for the accurate measurement of inductive loads, and to provide a meter adapted for use upon more than one rate of alternations and also adapted to record accurately on any and all of the various frequencies met with in alternating-current practice. It is well known that the customary manner of measuring inductive loads and obtaining a lag of ninety degrees in the shunt or volt magnetism behind the electromotive force which it represents in alternating-current motor meters now in use is by the employment of the resultant magnetic effect of a plurality of shunt coils of differing phase, which, when combined with the magnetism of a suitable series coil representing the amperes, produces rotation of the revoluble metallic armature in a well-understood manner. This desired result is secured in the present invention without the necessity of employing any closed secondaries in conjunction with the shunt or volt coil by utilizing the hysteresis and reluctance of a solid magnetic core in cooperative relation with the shunt or volt coil. The present improvement is also adapted to overcome an objectionable defect found in the meters at present in use—*viz.*, their inability to adapt themselves to a wide range of frequencies—as, for example, from 60 to 140 periods—without periodicity. To make the speed of the armature in an induction motor meter constant with the constant load on different frequencies, some means must be provided by which the changes in periodicity and rate of cutting of the lines of force through the armature must be compensated for by an inverse change in the density of flux before the armature will respond alike to a given wattage for differing frequencies—that is, if a meter is adjusted for, say, 140 periods, then by using the same meter on sixty periods the reduction in the alternations causes a reduction in the rate of cutting of the lines of force, which would as a consequence reduce the inductive effect upon the armature, thereby causing it to run slower than on the 140 periods with the same number of watts; but by increasing the strength of the magnetic field by an amount that will balance and compensate for the reduction in the rate of cutting due to a reduced frequency the speed of the armature will remain constant for a constant load irrespective of the change in the rate

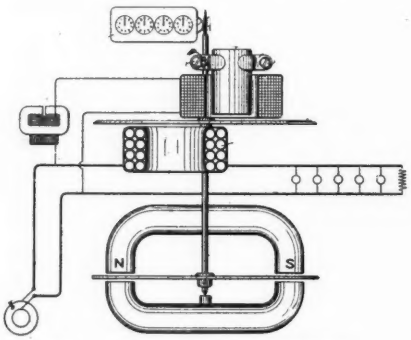


FIG. 1.—IMPROVEMENT IN METERS.

of alternations. Again, if the meter should be calibrated for sixty cycles, and it is desired to utilize it on 140 periods also the shunt or pressure field coil must be so organized that when it is subjected to the higher frequency its magnetic field must be reduced automatically in density by an amount that will balance the tendency to increase torque due to the increased rate of alternations and subsequent increased rate of cutting. The demand for such a meter or one that can adapt itself to any of the present periodicities met with in modern central station work is rapidly increasing on account of the many older stations being equipped with high-frequency apparatus, and the present additions being low-frequency apparatus in order that their business may successfully include the operation of motors. For this reason a number of central stations are obliged to carry two different classes of induction motor meters, one class adjusted for low frequency and the other for high frequency, which causes much confusion and annoyance in keeping them separated. Another practice which exists to-day is the feeding of low-frequency currents during the day for power purposes principally, and during the night, when motors are out of service, the high-frequency dynamos are switched upon the same circuits for lighting purposes, thereby introducing a condition that can not be met by any induction meter upon the market at the present time. It must also be borne in mind that in addition to overcoming the foregoing obstacles the meter must be able to also measure accurately lagging currents with the various frequencies as well as non-lagging or non-inductive currents. To overcome the foregoing objections by producing a meter that can be used on any rate of alternation and measure both inductive and non-inductive loads is the principal object of the present invention. Mr. Duncan has experimentally discovered that if a solid tool-steel core be inserted into the pressure or volt field coil of an induction meter that a uniform speed of the meter armature can be maintained with a uniform load in watts irrespective of the rate of alternations—*i. e.*, either 7,200 or 16,800, these being the two extremes in use at present. In connection with the foregoing it has also been demonstrated experimentally that by a proper adjustment of the solid tool-steel core and the convolutions comprising the pressure or volt field coil, the magnetism produced by the current in said coil can be caused to lag behind said current and maintained at a given angle of lag whether the current be 60 or 140 periods, thereby making it possible for the improved meter to measure inductive loads accurately on both 60 and 140 period circuits. The manner in which the foregoing conditions are maintained is upon the assumption that when the solid steel core is being magnetized by a high-frequency current its magnetizing effect upon the armature is represented by a given strength or density at a given rate of cutting, and when subjected to a low frequency the rate of cutting is decreased, but the strength or density of its magnetism is increased on account of the reluctance and hysteresis being less with the lower frequency and by an amount that compensates for the reduced alternations and rate of cutting. In this way the reluctance and hysteresis of the solid steel core adjust and govern the strength or density of its magnetism for the different periodicities, enabling it thereby to maintain a constant value for a constant electromotive force irrespective of the rate of alternations. The maintenance of the magnetic field in quadrature with the line pressure through the instrumentality of

the solid steel core with different frequencies and enabling the instrument to accurately measure inductive loads on said different frequencies is also due, no doubt, to the varying control by hysteresis and reluctance of the magnetism through said core. This latter quality may, for example, be ascribed to the solid steel core by assuming that with a high-frequency current the magnetism has a given phase relation with said current—say ten degrees behind it—and which may be assumed is also ninety degrees behind the line pressure. Then by passing a low-frequency current through the pressure coil that magnetizes the said solid steel core the reluctance and hysteresis of said core are reduced, thereby permitting a greater amount of effective magnetism through it, and by passing more magnetism through it the hysteretic eddy currents are increased, thereby maintaining the phase angle of the magnetism of the core at ninety degrees. The said increase in eddy currents compensates for the decrease in the self-induction of the pressure circuit which is traversed by the current magnetizing said solid steel core by increasing the magnitude or value of the eddy currents to balance the decrease in self-induction of the pressure circuit, so that on any frequency the effective magnetism through the solid core will be ninety degrees or the resultant of the hysteretic eddies in said core and the magnetism imparted to it by the current traversing the volt field coil surrounding it. While a solid magnetizable core has heretofore been employed, for the purpose of retarding the phase of the magnetism passing through it, in no instance has it been employed to further augment the magnetism produced by a previously lagged current, and which involves the lagging of a magnetic field to ninety degrees behind the line pressure which it represents. Nor has a solid steel core been employed in the shunt or pressure field coil of an induction motor meter to accomplish the other results hereinbefore set forth—*viz.*, to maintain the magnetism through it at a definite lag angle irrespective of the periodicity of the system, and making it possible thereby to measure inductive loads on a circuit supplied by currents of different periodicities.

Another of the patents relates to improvements in integrating wattmeters for the measurement of alternating electric currents and belongs to that class known as "integrating motor meters." (See Fig. 2.) The aim of this invention is to provide an improved method of and means for accurately measuring the energy expended on both inductive and non-inductive loads in alternating-current systems of distribution. Another object is to secure such an arrangement of the actuating parts that the magnetism representing the electro-motive force will lag ninety degrees behind the impressed electro-motive force. The invention com-

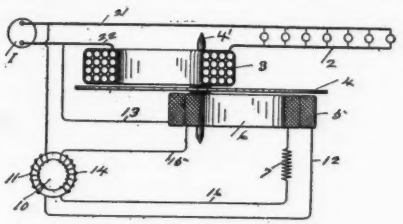


FIG. 2.—IMPROVEMENT IN METERS.

prises a series field carrying the main current, a compound shunt coil representing the electro-motive force in volts, a revoluble armature of the closed-circuit type arranged in inductive relation to the alternating magnetic fields of said series and volt coils and adapted to be actuated thereby, a transformer supplying currents to the compound volt coil, and means for adjusting the self-induction of the coils composing the said volt coil. Between the series coils 3 and the compound volt coils 5 and 6 and in inductive relation thereto the armature 4 is revolubly mounted, being rigidly fixed to a proper shaft 4^1, adapted to rotate in suitable bearings. The armature 4 may be a thin disc of aluminum or other metal of proper conductivity, or it may be in the form of a cylinder. To the upper end of the armature shaft 4^1 suitable counting or registering mechanism is properly geared. At one side of said disc-like armature or closed conductor 4 or in close proximity thereto is arranged the series coil 3. Upon the opposite side of said armature is arranged the said compound shunt or volt coil, the magnetism of which represents the electro-motive force in volts and which is formed of two coils, 5 and 6,

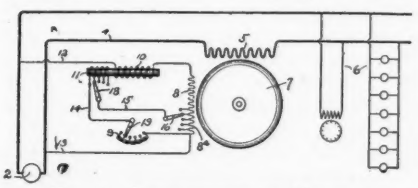


FIG. 3.—IMPROVEMENT IN METERS.

the latter arranged within the former. These coils, 5 and 6, have their magnetic axes concentric with each other and in parallel and eccentric relation with the axis of the series coil, and they receive their current from the transformer 10. The operation of the invention is as follows: The current from the generator 1 is transmitted to the translating devices or lamps 2 in the work circuit over the lines 21 and 22 and passing through the series coil 3 in its path, thereby setting up in said coil a magnetic field proportional to the current strength. When the translating devices are incandescent lamps or other non-inductive transformers of energy, the current and magnetism of the series coils will be approximately in step with the electro-motive force of the source of current. The rotation of the armature is produced by the resultant shifting field established by a difference of phase between the magnetism of the series coil and that of the compound shunt coil, the said field acting inductively upon said armature in a well-understood manner.

The third patent is somewhat along the line of the second above described, and relates to improvements in induction motor meters, and more particularly in means for obtaining a magnetic field in quadrature with the electro-motive force of the supply system represented by the said magnetism. (See Fig. 3.) The aim in this case is to simplify the method of obtaining a magnetic field that will lag ninety degrees behind the electro-motive force without employing a separate coil in cooperative relation with a volt or shunt coil—the method hitherto in vogue—and to provide a meter that will measure a lagging current or one displaced in phase from its electro-motive force. The principal elements entering into the construction of this meter are a source of alternating currents 2, supply mains 3 and 4, a series field coil 5, translating devices 6, a revoluble metallic armature 7, a volt coil 8, a resistance 9, an impedance coil 10, a phase-lagging coil 11, circuit wires 12 and 13 for supplying current to the said impedance coil and to the volt coils 8 and its auxiliary winding 8^a, circuit wires 14 and 15 for connecting the phase-lagging coil 11 to the portion 8^a of the volt coil 8, and a switch 16 for varying the number of turns of the portion 8^a of the coil 8.

"Telephone Service—the Modern Way."

The contract office of the New York Telephone Company is bringing to the notice of possible patrons the great advantages of private installations for hotels and apartment-houses. To do this the company has issued a magnificent pamphlet under the above heading. The book is beautifully printed in three colors on heavy woodcut paper, and is further adorned with a dozen or more splendid half-tone engravings. The whole is included in a handsomely printed envelope, making it a decidedly valuable souvenir advertisement.

An Important Polyphase Motor Decision.

In the Circuit Court of the United States for the District of Rhode Island, Mr. Justice Brown has just rendered a decision and opinion in the suit of the Westinghouse Electric and Manufacturing Company *versus* the Royal Weaving Company for infringement of the Tesla patents for polyphase motors. The opinion grants an injunction against the Weaving company, although it reserves decision as to whether the defendant may be permitted temporarily to use the motors which it now has installed.

The opinion of the court in full is as follows:

This is a petition for a preliminary injunction against infringement of patents No. 381,968, No. 382,279 and No. 382,280, granted May 1, 1888, to Nicola Tesla. These patents have been sustained, after full consideration, by the Circuit Court of the United States for the District of Connecticut in a suit against the New England Granite Company *et al*, 103 F. R., 951; and by the Circuit Court of Appeals for the Second Circuit, in the same case, 110 F. R. 753.

The defendant cites the language of the Supreme Court of the United States in Mast, Foos & Co. *vs.* Stover Mfg. Co., 177 U. S., 485:

"Comity, however, has no application to questions not considered by the prior court, or, in patent cases, to alleged anticipating devices which were not laid before that court.

"As to such, the action of the court is purely original, though the fact that such anticipating devices were not called to the attention of the prior court is likely to open them to suspicion."

The defendant contends that this Court should not be governed by the prior decisions, for the reason that it has before it new issues and new evidence.

The defendant relies principally on the French patent to Dumesnil, No. 161,564, dated August 8, 1884; and upon the French patent to Cabanellas, No. 168,172, dated April 9, 1885. It is said that the Dumesnil and Cabanellas patents disclose what was not before the courts of the Second Circuit, namely, that two single-phase synchronous motors could be coupled together, as by having their armatures mounted on the same shaft; and that these two motors might be run each by its own circuit of alternating currents, which might be supplied either by two single-phase alternating-current generators mounted on the same shaft, but so as to give currents out of phase with each other, or that a single generator such as was known in the prior art and which furnished the alternating currents of differing phase, might have been used as the source of supply.

While some of the general expressions of the opinions might have been modified, had the Dumesnil and Cabanellas patents been presented to the courts of the Second Circuit, a somewhat careful and laborious examination of these patents, and of the interpretations of them by experts, leads to the conclusion that these patents, if produced to the courts of the Second Circuit, would not have affected their decisions as to the nature and novelty of Tesla's invention, and as to the validity of the patents in suit. Neither does it seem to me that these patents would have affected the conclusion that the invention of Tesla was one of great novelty and merit.

The question whether Tesla was anticipated in the production of a rotary magnetic field for power purposes, by the use of alternating currents of different phase, was fully and elaborately argued in these cases, and fully and closely considered by the courts. By the decisions, it was found that:

"Tesla's invention, considered in its essence, was the production of a continuously rotating or whirling field of magnetic forces for power purposes by generating two or more displaced or differing phases of the alternating current, transmitting such phases, with their independence preserved, to the motor, and utilizing the displaced phases as such in the motor."

Also that he was the first to produce, by alternating currents, for power purposes, the shifting of the polar lines of the annular magnet through the entire circumference of the ring by the action of the magnetizing forces properly related.

A magnetic field wherein, by the cooperative action of two alternating currents, a resultant polar line progresses continuously towards the strengthening current, thus producing an effect as if a permanent magnet has been carried bodily around a rotable armature, I am unable to discover in the patents of Dumesnil or Cabanellas.

It is immaterial, therefore, to consider whether Tesla was the first to disclose the use of two alternating currents of different phase to rotate a shaft, or the criticism of those expressions in the opinions which may attribute to Tesla priority in the disclosure of the use of alternating currents of different phase for power purposes.

The decisions upheld the Tesla patents, and these patents well describe and claim the rotary magnetic field.

The sphere within which the defendant must show anticipation is narrower than that of the use of alternating currents of different phase, with an ultimate object of rotating a shaft. This renders much of the matter in the defendant's affidavits irrelevant to the question whether the prior decisions are controlling upon this petition for a preliminary injunction.

Narrowing the question, then, whether the defendant has disclosed any anticipation of the rotary magnetic field for which Tesla's patents were upheld, we will consider the contention based upon the Dumesnil and Cabanellas patents.

While the fact that these patents, though pleaded in previous litigation, were not put in evidence or brought before the courts, tends to awaken the suspicion that they have heretofore been considered too remote from the real questions presented by the Tesla patents, the defendant is still entitled to a consideration of the argument which it bases upon these patents.

Considering first the Dumesnil patent, and the drawings which are offered to show the "double crank action" of the alternating currents could, by their combined use, produce such magnetic effects as would be sufficient in themselves to rotate an armature; much less a suggestion that, by the combined use of two currents, a continuous rotary effect could be produced like that of a magnet carried bodily around the armature.

To couple two single-phase synchronous motors upon one shaft, displacing the poles of one armature angularly with respect to the other, so that one motor expends its maximum effort while the other expends its minimum effort, does not seem to me to exhibit the Tesla invention as described and claimed in the Tesla patents. In the opinion of Judge Shipman, it is stated that "Tesla must have a continuously rotating field."

The combination of two single-phase machines may have a "resultant" as distinguished from a summative effect upon the shaft; but the "resultant" of the operation of two machines is a different thing from the magnetic resultant of two currents upon a common element, as a Tesla ring or an armature within that ring.

If two single-phase machines are capable of rotating a shaft better than one machine, it is because the mechanical action of each single-phase machine is communicated through a shaft to assist the other machine. The armature of one machine would then be subjected, first, to a magnetic effort from its own field magnet, then to a mechanical effort from the shaft, which would bring it in position for the next magnetic impulse. The whole operation of the two single-phase machines in combination would be from intermittent magnetic and mechanical efforts—neither magnetic field would be a rotary.

To show Dumesnil's combination of two single-phase machines, however, it is necessary to add another factor: The action of the magnetic poles of his armatures. Dumesnil nowhere suggests that continuous rotary action or tendency will result without the opposition of the magnetism of the armature to the magnetism of the field poles, or that by induction the field poles will properly magnetize the armature. Dumesnil, therefore, does not anticipate, since he fails to show that two alternating currents can, merely by combination of their magnetic effects, produce a continuous rotary effort, or that the action of two different magnetic forces upon a common element will give a resultant magnetic pole which exerts its force at positions intermediate of the field poles.

If we concede that Fig. 9 of the Hering affidavit might be considered as a mere mechanical consolidation of Figs. 7 and 8, we can not accept the statement that Dumesnil shows beyond question the arrangement of Figs. 7 and 8, as adequate to produce a constant rotary effect upon a shaft. Dumesnil nowhere discloses or suggests the idea

that such an electrical device as is shown in Figs. 7 and 8 can produce a rotary effect upon a shaft. The magnetic poles of the armature are described by him as features essential to rotary motion. His patent must be considered as a mere publication, giving a description and plan of operation. To make figures of the Hering affidavit illustrate both Dumesnil and Tesla, it is necessary to ignore what Dumesnil proposes as an essential feature.

Dumesnil, in my opinion, does not show a magnetic polar line, which is the resultant of two alternating currents of different phase; neither does he show any plan for producing a rotary effect merely by the unaided action of two alternating currents.

THE PATENT TO CABANELLAS.

This patent, upon many readings, seems to me to be fairly characterized by the complainant's counsel as "expressed in such obscure and indefinite terms as to be hopelessly unintelligible, except in a few unimportant particulars," and as requiring an exceptional exercise of the imaginative powers in translating its phrases into electrical diagrams.

It is contended that Cabanellas, like Dumesnil, contemplated arranging two single-phase machines side by side with the elements displaced so as to displace the phases of the currents, and thus get a continuous rotary effort from two currents. But, like Dumesnil, Cabanellas fails to show a magnetic pole which is the resultant of two alternating currents. When, therefore, the defendant's experts say that the armatures of Dumesnil and Cabanellas are caused to rotate "by the rotation of resultant magnetic attractions set up the joint action of two or more alternating currents of different phases," and that "these features of the prior Dumesnil and Cabanellas patent cover the ground of the Tesla patents in suit, and in substantially the same manner when the said patents are given a broad interpretation in accordance with the decisions of the court;" their testimony must be regarded as based upon a misinterpretation of the decisions of those courts, and upon a failure to recognize that it was expressly found that Tesla must have as a resultant of the currents a continually rotating field of magnetic forces. The "resultant" of the decisions is that which is produced by combining upon a common element the magnetism created by two alternating currents. This magnetic resultant, applied to power purposes, I understand to be the Tesla invention. The defendant's "resultant" is not a magnetic resultant, but merely the rotation of the armature.

Conceding that Dumesnil, Cabanellas, and Tesla all rotate an armature, the point for comparison is as to the way in which this rotation is accomplished. Conceding, further, for the purposes of this petition, that all employ alternating currents of different phase, Tesla alone discloses means whereby two alternating currents may so magnetize a common element as to produce a force with a constant rotary effect. Dumesnil and Cabanellas at best show the combined use of two motors of an old type having the characteristic defects of such motors, and lacking the characteristics of the Tesla motors. Even if two of these motors can assist each other by so timing their mechanical efforts that one exerts its maximum effect while the other exerts its minimum effect, I do not find in such a combination of two machines the invention of Tesla, nor the "rotary field" which was apparently conceded by the defendant in the prior suits to be the proper subject-matter of controversy in determining the validity of the Tesla patent.

This defendant seeks to show anticipation by an interpretation of the prior decisions which is too broad; and does not, in my opinion, show anticipation of what was decided to be the Tesla invention, and the subject-matter of his patents.

The question of infringement seems to be substantially determined by the prior decisions.

The question of laches and estoppel do not require extended discussion. These matters were ably and carefully presented at the hearing, and the opinion formed by me at that time was adverse to these contentions. Upon an examination of the entire record relating to these points, my opinion is confirmed that this defendant decided the question of adopting its motors as a mere business proposition; that it contemplated, as a part of this proposition, the risk of infringing the complainant's patents, and took the risk with its eyes open, relying upon protection from its vendors or from others; consequently, upon this hearing, it must stand by its business proposition. I fail to see that the defendant has in any way been inequitably treated by the complainant.

It is implied by the argument that if a patentee does not see fit to shape his business to suit the wishes of persons who desire to use his invention, this in some way creates an equity which entitles such persons to use the invention in such specific form as they prefer, without the consent of the patentee. I see no ground for thus abridging the rights of the patentee.

The objection to granting a full preliminary injunction is the hardship which would result to the defendant and its employés from preventing the use of the motors now installed in the defendant's factory. This objection, however, is insufficient to deprive the complainant of all right to a preliminary injunction, but goes rather to the question of the extent of the decree. The record upon this petition is voluminous; and we must recognize the possibility of error upon a subject of considerable complication and difficulty and should seek to avoid so far as possible mischief which might arise before such error can be corrected. It is also due to the complainant that we should recognize that it has established the validity of the patents after meeting and overcoming a most skillful and elaborate defence; and that its rights, thus established, should not be evaded or rendered worthless by unnecessary delay in their enforcement. While there are objections to determining questions like those raised upon this petition, save upon final hearing, the court must also consider that it is objectionable to refuse an injunction merely because of voluminous or complicated matters of defence.

This defendant, to avoid the effect of the former decisions, should show, not only that new matters and new issues are presented but that the new matter might require a different decision as to the character of Tesla's invention and as to the validity of his patents. Though the argument for the defendant has been presented forcibly and with ability, I am of the opinion that the defence to this petition is insufficient, since it does not seem to me to meet the points actually decided by the Courts of the Second Circuit.

Upon the complainant's brief, it is suggested that the order for a preliminary injunction can be granted upon terms which will impose no hardship or unnecessary damage upon the defendant, its employés, or the public. To such an injunction, with special terms as to the motors actually installed and in use in the defendant's factory, I am of the opinion that the complainant is entitled. Under all the circumstances, it would seem hardly necessary to make an immediate order permitting or requiring the gradual substitution of licensed for unlicensed motors. The complainant probably can be sufficiently protected as to these motors by a suitable bond, and by terms as to the speedy prosecution of the case to a final decision. The questions whether the defendant may be permitted to continue temporarily the use of the motors now installed and if so upon what terms, are reserved.

An Interesting Invention.

A combination revolver and dark lantern is described in a current number of the *Scientific American,* which would be of great value and service in case of emergency at night. Its distinguishing feature lies in a small incandescent lamp which is situated in a reflector tube placed immediately below the revolver barrel. A battery in the handle of the revolver may be electrically connected with the lamp by a slight pressure of the trigger. Thus, should a man suspect a burglar in the house he could use his revolver as a dark lantern to ensure good aim before firing, locating his victim by the aid of the electric lamp. The electric wires are separated as soon as the piece is fired, the trigger returning to its normal position, the shooter thus being afforded the extra protection of darkness in case, with all these auxiliaries, he should miss that at which he had been firing.

British Tramways Exposition.

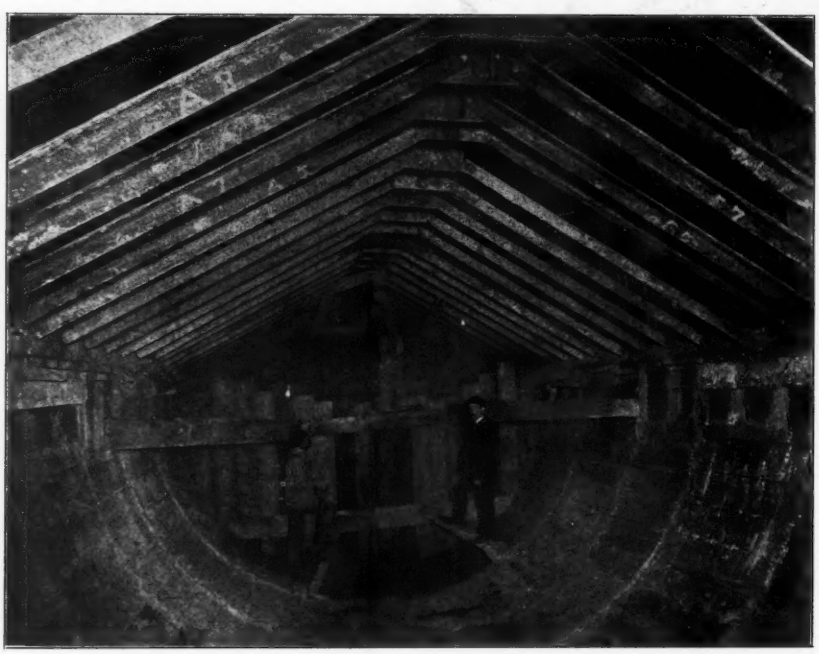
The second International Tramways and Light Railways Exposition will be held at the Royal Agricultural Hall, London, from July 1 to July 12, 1902. A large number of exhibits have already been spoken for, and it is expected that this will in every way be as successful a convention as the event held in 1900.

The Tunnel Subways of Chicago.

Extensive Undertakings of the New Independent Automatic Telephone Company.

FORTY feet below the streets of Chicago several hundred men and half a hundred mules are working night and day boring great conduits to carry the cables of the Illinois Telephone and Telegraph Company, which is to install an independent telephone exchange for the use of the Chicago public.

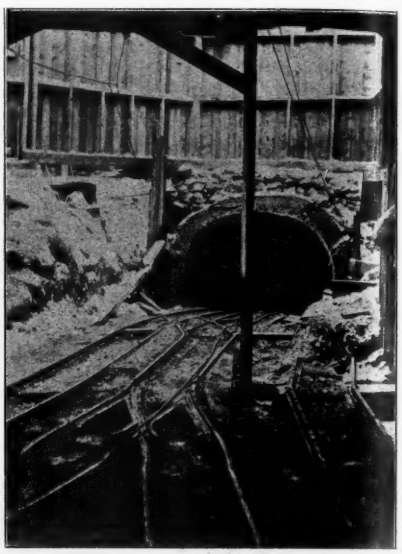
The outside world has known very little of this great project. In fact, it may be said that the thousands who daily tramp the streets of this great western metropolis have, until lately, been totally ignorant of the progress which has been made, for the reason that the company was obligated in its franchise not to impede street traffic in any way, and has, therefore, brought all material into its shafts and removed all excavated dirt by night. On April 26 and 27, however, invitations were issued to the business men of the city to inspect the work, and 2,000 of them were guests of the telephone company and made a trip through the great underground tunnel system, which has now eight miles of tunnels completed in the heart of the business district of the city. The size of these tunnels is six by eight feet, except in trunk sections, which is twelve by fourteen feet.



BRACING OF CONCRETE FRAME IN TRUNK SECTION, TUNNEL OF THE ILLINOIS TELEPHONE AND TELEGRAPH COMPANY.

In order to do this work in the rapid and systematic manner in which it has been accomplished, the company found it necessary to sink eight shafts and bore toward points of intersection. The work of its civil engineers was most successful in this, and so accurate were their calculations that when gangs coming toward each other met, there was not more than one-eighth of an inch difference in their course.

Chicago is built upon a blue clay foundation, the clay being almost like putty. Through this the excavating gangs cut their way with knives designed by the contractors in charge, two men, working face to face, being needed to handle each knife. Wherever the clay was found too hard for the knives to cut, it was dug out with a peculiar clay adz, which the contractors also devised. As fast as the clay was cut it was loaded into dump carts, which were side-tracked to await the evening hour, when they could be hauled to the shafts and their contents transferred to wagons. At the same time this excavation was going on underground, the concrete which was to be used in finishing up the tunnels was being prepared in a basement at the mouth of each shaft. This work was done as rapidly as the excavations were made. These concrete facings are ten inches in thickness, and are estimated to be much more durable and more effective than a facing of brick two feet thick.



MOUTH OF SLOPE, CONGRESS STREET AND CHICAGO RIVER, THE TUNNEL OF THE ILLINOIS TELEPHONE AND TELEGRAPH COMPANY.

All this work of excavating and forming has been done under an air pressure of ten pounds to the square inch, this pressure serving to hold back the water, at the same time making a perfect setting for the concrete. Air compressors and reservoirs were installed at each shaft, and a system of perfect air locks was placed at the bottom of each shaft and at the mouth of the tunnels leading therefrom. The construction of these air locks, whereby material could be admitted to the tunnels or taken out without disturbing the pressure, is familiar to all readers of the ELECTRICAL REVIEW.

The construction work has been remarkably successful. A walk of hours can be made through the tunnels without any inconvenience. The walls are clean and white, with a perfectly smooth surface, and the air is pure and wholesome. Three million dollars have already been expended and seven millions more will be spent in completing the work. The enterprise has now progressed so far that a slope, which has its mouth on the river near Congress street, will be used for the removal of all excavated clay. There it is dumped into scows and towed away by tugs.

Mr. A. G. Wheeler, who is president of

the Illinois Telephone and Telegraph Company, is well known in the engineering world, having been prominently identified with a number of large and successful enterprises. His work in connection with the construction of various underground trolley systems has also made him prominent in the electrical field. Mr. C. D. Simpson, of Scranton, Pa., is vice-president of the company. Mr. E. W. Gearhart is secretary and Mr. H. H. Braddy, treasurer. The board of directors consists of Mr. C. D. Simpson, J. B. Russell, C. B. Eddy, A. G. Wheeler, J. Harris and E. W. Gearhart. Mr. George W. Jackson is chief engineer and general superintendent of the construction work. Mr. Jackson has been identified with a number of important engineering schemes, one of the most prominent of which was the construction of the aqueduct through Pike's Peak, which supplies the city of Colorado Springs with water. This remarkable undertaking was his own conception and is a monument to his ability.

A matter of vital importance to the Illinois Telephone and Telegraph Company in the successful outcome of its project was the selection of a telephone system which would enable it to offer to the Chicago public a service that would at once secure public patronage. The company argued that, in competition with the Bell concern, it must be able to say to the people of Chicago that it could give them a superior and a cheaper service. With this end in view it selected the Strowger automatic apparatus manufactured by the Automatic Electric Company, of Chicago, as, in its opinion, best suited to the purposes of the company and the needs of the public. The company will, therefore, say to the people of Chicago, when it begins to install its system, that it guarantees each user of its telephones: (1) a strictly "private wire" over which to talk; (2) a service which can not be interrupted; (3) a service which is automatic throughout and, therefore, necessarily prompt and accurate.

The maximum charge for business telephones will be $85 per annum, and the charge for residence telephones $50 for the same period. The company will, however, place a telephone in any office or business house of good standing to be used and paid for at the rate of five cents per call, the maximum charge to be $85 per annum, as above stated. It is enabled to do this by means of an ingenious device, on each subscriber's switch at the central office, which automatically registers each connection that is made for him. In this way an accurate record of his business can be kept and a bill presented at regular periods for actual use of the telephone. The company believes that this system will enable it to place in a short time many more telephones than were ever before used in Chicago. It believes that every one will be glad to secure its service on these terms, and that the patronage of the automatic system should quickly outnumber that of the Bell company, and that at no distant day there should be at least 100,000 of these telephones in use in Chicago.

This is, without doubt, the greatest telephone undertaking in the history of telephony, and the telephone world will watch the outcome with intense interest; first, because of its radical departure from present telephone methods; and second, because of the great amount of capital involved in the enterprise.

INTERSECTION OF DEARBORN AND VAN BUREN STREETS, IN THE TUNNEL OF THE ILLINOIS TELEPHONE AND TELEGRAPH COMPANY.

Book Reviews.

"Standard Polyphase Apparatus and Systems." M. A. Oudin. Third edition. New York. D. Van Nostrand Company. Cloth. 289 pages. 5¼ by 8 inches. 169 illustrations. Supplied by the ELECTRICAL REVIEW at $3.00.

This excellent work is too well known from its former editions to require any extended notice here. In preparing the third edition it has been brought well up to date and revised in many particulars. It is to be regretted that the publishers used a variety of paper resembling cardboard in the manufacture of this volume

"Electrical Engineering Testing." G. D. Aspinall Parr, London. Chapman & Hall, Limited. Cloth. 474 pages. 5½ by 8½ inches. 218 diagrams and 31 tables. Supplied by the ELECTRICAL REVIEW at $3.50.

This book is intended to be used in the laboratory and to form a systematic course of instruction in electrical testing. Its general method and arrangement are admirable, but the examples given of practical work relate generally to practice of an exclusively British character, while the instruments described are not those in use in this country.

"The Balancing of Engines." W. E. Dalby, London. Edward Arnold. Cloth. 285 pages. 5½ by 9 inches. 173 illustrations. Supplied by the ELECTRICAL REVIEW at $3.50.

This valuable work is an example of the very thorough application of analytical principles to a practical case. The main object of the book is to develop a semi-graphical method which may be used with consistency in attacking the problems connected with the inertia forces arising from the different movements of the parts of an engine or machine. The method is interesting and is most elaborately worked out. The book is one that might find considerable practical use in the drafting room of an engine manufacturing concern.

"Armature Windings for Direct-Current Dynamos." E. Arnold; translated from the German by F. B. De Gress, New York. D. Van Nostrand Company. Cloth. 124 pages. 6 by 9 inches. 146 illustrations. Supplied by the ELECTRICAL REVIEW at $2.00.

This work is an attempt to develop for all varieties of direct-current armatures a general rule applying equally well to all in which the winding is of the closed-coil variety. The work is well illustrated, with good diagrams which vastly increase its value. A chapter deals also with open-coil windings, such as are used in arc light machines of the Brush and Thompson-Houston types.

"The Elements of Physical Chemistry." J. L. R. Morgan, New York. John Wiley & Sons. Cloth. 352 pages. 5 by 7½ inches. 23 illustrations. Supplied by the ELECTRICAL REVIEW at $2.00.

Dr. Morgan's book is primarily intended as a text-book in the study of physical chemistry. It makes a fairly free use of mathematics, although in general the attempt has been made to keep out of the formula the expressions of the calculus. This hardly seems desirable, as students of physical chemistry may be supposed to know something about the calculus, and any attempt to simplify the mathematics of the subject is liable to result in an increase of complexity. The work is very condensed, and seems to be an admirable text-book for students in an introductory course in the subject.

"Dynamos, Motors, Alternators and Rotary Converters." Gisbert Kapp, translated from the third German edition by H. H. Simmons, London. Biggs & Company. Cloth. 503 pages. 5½ by 9 inches. 200 illustrations. Supplied by the ELECTRICAL REVIEW at $ ——.

Mr. Kapp's book is already well known from the former English edition. It is a work of genuine engineering merit, distinguished from the majority of other works of the same character by its practicality. The calculations given in it are in no way long, and are always as simply handled as the subject permits. Wherever it has been possible to use graphic methods in place of analytical, this has been done. The book forms also a useful compendium of European methods in the construction of actual machines. It is not intended for non-technical readers, but presupposes a considerable knowledge of the subject.

"American Street Railway Investments." Ninth edition. New York. The Street Railway Publishing Company. Cloth. 305 pages. 9 by 13 inches. Many maps and diagrams. Furnished by the ELECTRICAL REVIEW at $5.00.

The ninth edition of this excellent work is in its general arrangement very similar to those that have preceded it, except that this time the maps are a good deal better. Thirty-one folding maps, some of which are in colors, are used to illustrate the more important street railway systems. Comparisons of the gross receipts of all companies earning $25,000, or more, for the years 1900 and 1901, are given. The edition contains reports of 1,281 companies, showing their financial and physical condition in full. Figures are also given of all important consolidations that have taken place during the year. These reports in each case are followed by the date of the information as supplied by the companies making the report.

"Self-Propelling Vehicles; a Practical Treatise on Automobiles." Jas. E. Homans, New York. Audel & Company. Cloth. 632 pages, 6 by 9 inches, 466 illustrations, many tables, etc. Supplied by the ELECTRICAL REVIEW at $5.00.

This excellent work was compiled with a view to giving the general reader, not necessarily versed in technical matters, a comprehensive idea of the construction, operation, care and management of automobiles of all the well-known types. The book is full of detail and goes into the questions of engine and motor construction, of wheels and tires, steering gear and the details of boilers, storage batteries, carburetters and the other auxiliaries of the automobile with great clearness and simplicity. The majority of the illustrations are diagrams directly to the point, only a few of the familiar catalogue engravings being used. The work is in no sense a trade catalogue of automobiles, but is a practical treatise which can not fail to prove of really high value, as well as of great interest, to all owning automobiles or contemplating their purchase.

"Electrical Power Transmission." Louis Bell. Third edition, revised and enlarged. New York. *Electrical World and Engineer* Publishing Company. Cloth. 632 pages. 285 illustrations and 21 plates. 6 by 9 inches. Furnished by the ELECTRICAL REVIEW at $3.00.

This new edition of Dr. Bell's admirable book has been very greatly enlarged and almost rewritten. The constantly advancing progress of the subject has necessitated many additions to the original text, as well as the illustration of many examples of new practice. A chapter on commercial electrical measurements has been added, and a final chapter on the present state of high-voltage transmission has been utilized to bring the latest developments of the art before the reader. It is hardly necessary to review so well known a work at great length. The ability of the author is well known, as is his unusual power of expressing himself in concise, and, at the same time, highly literary form. Indeed, Dr. Bell is to-day practically the only writer in English on electrical subjects who combines with singular clearness of expression a literary style that may be called brilliant. The work is extremely complete, and the illustrations numerous, though not always excellent. Better paper and printing would have improved the general makeup of the volume. The work has become a classic already, and this new edition is one that will prove itself not only of deep interest to its readers, but doubtless of high practical value as well.

Annual Institute Business Meeting.

Reports of Directors and Treasurer, and Election of Officers. Papers on Polyphase Traction—I.

ON THE evening of Tuesday, May 20, the annual business meeting of the American Institute of Electrical Engineers was held, the principal question to be considered being the count of the ballot for officers for the ensuing year. As usual, the nominees of the board of directors were elected as follows:

President, Charles F. Scott, of Pittsburg; vice-presidents, C. O. Mailloux, of New York, and Schuyler S. Wheeler, of New York; managers, Townsend Wolcott, Gano S. Dunn, E. H. Mullin and Charles A. Terry. Messrs. George A. Hamilton and Ralph W. Pope were reelected treasurer and secretary, respectively, by a unanimous vote. Two papers were presented, as follows: "Some Notes on European Practice in Electric Traction with Three-Phase Alternating Currents," by Carl L. de Muralt, the paper being read by its author. The second was "A Novel Combination of Polyphase Motors for Traction Purposes," by Ernst Danielson. This paper was read in abstract by President Steinmetz. It appears below in full. Mr. Steinmetz said, in reviewing this paper, that it seemed to him to be of unusual importance. The theory of the operation of induction motors in cascade was already well known when the usual case in which the two motors were of the same size was considered. Mr. Danielson's experiments and conclusions had shown that there might be advantage in making them of different sizes.

Mr. de Muralt presented an extended abstract of his paper and a number of very interesting lantern slides showing the details of European installations of three-phase railways.

The discussion was opened by Mr. C. O. Mailloux. He analyzed the paper at great length and stated that he had had reason within the last year, after an extended study of the various plants referred to, to first conclude that alternating current was of great value for railroad purposes, and then subsequently to change his mind. He considered that the acceleration which could be had from polyphase motors was insufficient for the purposes of the usual electric railroad as it had to be constructed in practice.

President Steinmetz, in summing up the discussion, spoke of the small capacity of the European railways described. He said that on the Albany & Schenectady interurban trolley road, with which he was familiar, the power installed on the ordinary trolley car was 140 horse-power, and that in hill-climbing these cars often, and indeed usually, consumed 800 amperes of current at 500 volts. Now, the whole power equipment of the Gornergrat railroad is only 175 horse-power, or not much more than that of an ordinary American cross-country trolley car. In summing up the whole question of the application of polyphase currents to electric railways, Mr. Steinmetz stated that he agreed with the author of the paper that every situation which was presented to the engineer required the careful study of all its conditions before determination could be made of the best method of handling and equipping the line. Notwithstanding his belief in this point of view he had not yet in his experience discovered any situation in which polyphase current was absolutely indicated by the conditions of the problem. He went on at length to discuss the varying characteristics of electric motors of the two kinds with reference to their availability for railway work. He laid special stress upon the high accelerations possible with the direct-current motor, and stated his conviction that the railroad operation of the future would tend more and more to what might be called high-speed local trains, that is, to trains operating at high-overall schedules and making frequent stops, consequently requiring tremendous accelerations in leaving stations. Under these circumstances, the exigencies which might lead to the belief that alternating current was an ideal method of operation would disappear, and he believed that the future of electric railroads was bound up in the use of direct current unless, perchance, somebody should come along and invent a single-phase alternating-current motor which would give a starting torque several times as great as the running torque, and would slow down under load, exhibiting the same characteristics as the series-wound, direct-current motor.

The discussion was long and interesting, and was participated in by Messrs. Stott, Wolcott, Hammer, Henshaw, Sperry and others. At the conclusion the usual compliment of a vote of thanks was paid to Mr. de Muralt for his excellent and interesting paper.

A NOVEL COMBINATION OF POLYPHASE MOTORS FOR TRACTION PURPOSES.

BY ERNST DANIELSON.

During the last few years there has been a great deal of discussion as to the possibility of using alternating-current motors economically for traction purposes. The result so far obtained seems to be that while these motors may prove successful not only technically but also commercially in special cases, yet as a rule they are inferior to the direct-current series motor for general work. The reason for this is that the polyphase motors behave like shunt motors—*i. e.*, operate economically only at a certain speed and that accordingly other speeds are obtained only with a sacrifice in economy. It is true also that the induction motors have other drawbacks; for instance, the wattless currents which necessarily belong to them, but it seems that the advantages which they possess in simplicity and of doing away with substations using rotating machinery are important enough to compensate for the disadvantage of wattless currents. It has also been pointed out by Mr. Scott at the Buffalo convention when advocating the direct-current motors for electric railway service, that the invention of a speed-changing device might change the situation. The author here proposes to deal with an arrangement which makes it possible to obtain economically four different speeds by means of only two motors—an arrangement which, it seems, will do away with some of the difficulties now experienced in applying the induction motors for railway work.

As is well known, the concatenated control of two induction motors consists in connecting the secondary circuit of one to the primary of the other, mechanical connection being arranged so as to make the moving parts of both motors always run at the same speed. In this way a combination is obtained giving a speed corresponding to half of the regular speed of each motor. The torque of each motor will be the same when used single or in concatenated connection. This means that the output of the concatenated combination is only half of the output of the motors operating independently. If instead of using two similar motors to motors of different speeds (*i. e.*, with a different number of poles) are combined in concatenated connection a speed is obtained which corresponds to a number of poles equal to the sum of both motors. Suppose a combination of a six-pole and a four-pole motor and that the frequency

equals fifty cycles per second; then three different speeds are possible, *viz.:* The speed of the four-pole motor alone (the six-pole motor running idle) equals 1,500 revolutions per minute (minus slip); the six-pole motor speed equals 1,000 revolutions per minute, and the combination speed equals 600 revolutions per minute. If both motors are of the same horse-power—say, for instance, fifty horse-power—it is easy to see that the combination gives also fifty horse-power. By means of this arrangement we have accordingly got a motor capacity of fifty horse-power at three different speeds, 1, 500, 1,000 and 600 revolutions per minute.

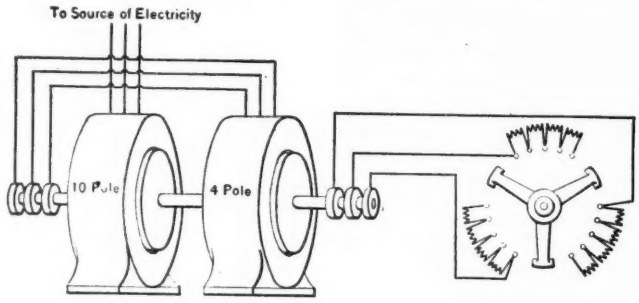


FIG. 1.

But it is possible to go still further. When connecting in concatenation we have the possibility of making the connection either so that the torque of both motors works in the same direction or by crossing the leads combining the secondary of the first motor with the primary of the second to get a resultant torque which is the difference between those of the two motors. This arrangement may be called a differential concatenated connection. In order to see the result of this, let us suppose two motors, one with ten poles and one with four poles, both of same output, say fifty horse-power each, the motors of which are mounted on the same shaft. (Fig. 1.) If now the source of electricity be connected to the stator of the four-pole motor, and the rotor winding of the same motor be connected to the rotor winding of the ten-pole motor in such a way that the magnetic field in both rotors will revolve in the same direction relatively to their cores—then the torques of both motors will be opposite to each other. As both motors have the same output, then if the torque of the four-pole motor be called unity, that of the ten-pole motor will be 2.5, accordingly the resulting torque in this case will be 2.5—1 equals 1.5 and acting in the same direction as that of the ten-pole motor. As the system begins to move, the frequency in the circuit belonging to the rotors increases, whereas the frequency in the stator of the ten-pole motor decreases. Started in the regular way by inserting resistance in the last secondary and gradually cutting it out, the speed comes up until the frequency in the stator winding of the ten-pole motor approaches zero, which will happen when the speed is 1,000 revolutions per minute (the frequency is as before assumed equal to fifty cycles per second); that is to say, we have obtained at motor running at 1,000 revolutions and with a torque which is represented by 1.5; the torque a 1,500-revolution motor (four-pole) of fifty horse-power being equal to 1. Accordingly the horse-power of this arrangement is still fifty. By means of this combination of two motors we can thus obtain the same output under the following conditions: 1:*o*. The four-pole motor alone—the ten-pole running idle—speed 1,500 revolutions per minute 2:*o*. Differential concatenation speed equals 1,000 revolutions per minute 3:*o*. Ten-pole motor alone—four-pole motor running idle—speed equals 600 revolutions per minute 4:*o*. Regular or direct concatenation—speed equals 428 revolutions per minute. These torques and speeds are graphically represented in Fig. 2, which gives the torque for any of the speeds with regular full-load current on a twenty-horse-power motor. No attention is, however, given to the lag which, of course, is considerably greater in the concatenated connection—direct or differential—than with one motor alone.

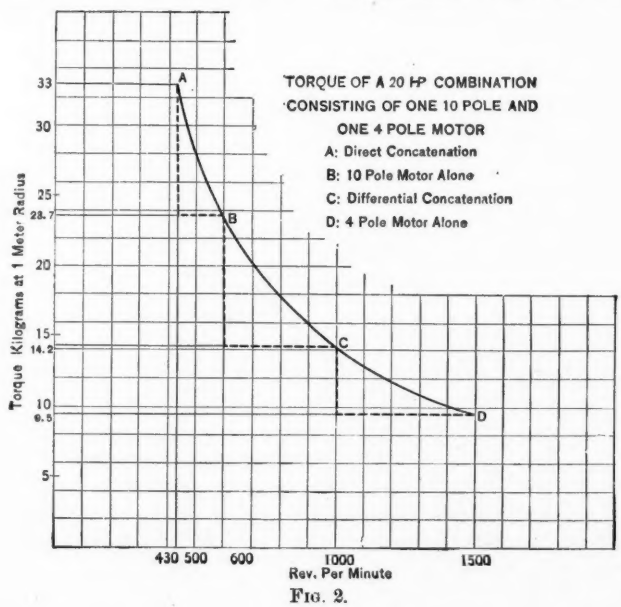


FIG. 2.

Fig. 3 shows a small motor built on these principles and which is intended for running tool machinery in a workshop. It is designed with one side ten-pole (large diameter) and the other four-pole and accordingly gives the name synchronous speeds 428, 600, 1,000 1,500.

It goes without saying that if gearing of some kind be used, the motors need not have different numbers of poles; for instance, if both motors are identical and are geared to the same shaft so that one gives a speed 0.617 of what the other gives then the speeds which are possibly obtainable form a geometrical series the ratio of which is 0.617; that is to say, it is possible to obtain four different speeds, each of which is 0.617 of the one which is nearest higher.

Before investigating how this method can be applied for railway motors there should be pointed out some features which are interesting in the differential concatenation. As has been first noticed by Steinmetz a system of two equal motors in concatenated connection can operate at two different speeds, one of them being practically the same as if the motors were driven independently, that is to say, double the speed of the concatenated speed proper. With a system of two unequal motors the same phenomenon appears; a concatenated pair consisting of one six-pole and one four-pole motor can

also run—with six-pole speed if the six-pole motor is connected to the source of electricity and with four-pole speed if the four-pole motor is nearest the source. In all these cases there is no risk of obtaining these secondary speeds instead of the one which is desired, because the desired concatenated speed is always lower than the secondary speeds. Thus when the desired speed is reached the motor can not of itself get higher.

With the differential concatenation the matter is a little more complicated. Above when describing the differential method we have for the sake of simplicity assumed that the motor with the fewer number of poles was used as the primary motor, *i. e.*, connected to the generator circuit. In this case the secondary speed which is obtainable is the speed of the prime motor itself and in opposite direction to the differential concatenated speed proper. Consequently there is not even here when starting any possibility of getting the wrong speed instead of that desired. But suppose that the ten-pole motor had been the primary motor. Evidently the starting would take place in the same way as before, but when the speed of 600 revolutions is reached the motor would not get up any higher, but would continue to run and develop torque as soon as the speed falls a little short of 600 revolutions per minute. That, however, also with this connection the differential speed of 1,000 revolutions (minus slip) works just as well as with the other connection will be clear from the following:

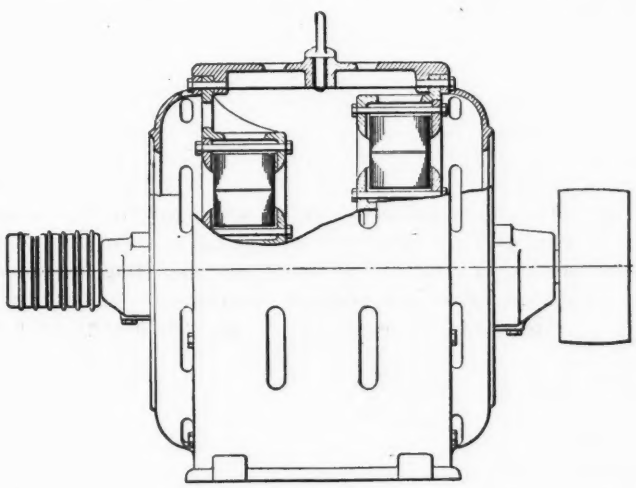


Fig. 3.

Suppose that the connections are exactly as before described for differential concatenation only, with the difference that the generator is connected to the stator winding of the ten-pole motor and the rheostat to the stator of the four-pole motor. If now the rotating field in the ten-pole motor rotates clockwise and by some external force the machine is speeded up to, say, 970 revolutions per minute clockwise, what will happen? The magnetic field in the ten-pole rotor moves relatively to the iron core with a speed of $600 - 970 = -370$ revolutions per minute, and its direction of rotation accordingly is counter-clockwise in the iron. The relative speed of the magnetic field in the four-pole rotor then is $-370 \times 10/4$, also counter-clockwise. The absolute speed therein is clockwise and $= 970 - 370 \times 10/4 = 45$ revolutions per minute. Evidently when this field revolves clockwise—in the same direction as the movement, the four-pole motor acts as a generator. The action is exactly the same as that of any induction motor with its primary element rotating, running at a higher speed than synchronism. Now the currents from this generator are used to speed up the ten-pole motor, when at the same time evidently the torque required for running the four-pole generator part of the system is subtracted from the ten-pole motor part. The case is analogous to this: Take a regular induction motor and connect not only its primary but also its secondary to the source of electricity. Then with proper connections we can obtain twice the regular synchronous speed of the motor.

That the ten-pole part of the motor system in this case acts as a motor and not as a generator can be proved in this way. When in an induction motor the speed of the rotor falls short of the synchronous speed, then the current induced in the secondary winding is nearly in phase with the electro-motive force that produces it, that is to say, the rotor winding carries what might be called a generator current. If then the rotor increases its speed so as to exceed that of the revolving field of the primary then the electro-motive force induced in the secondary part (rotor winding) would change its phase by 180 degrees in relation to the magnetic field; hence it is clear that the current in the secondary winding now has to be in opposition to the phase of the electro-motive force, that is to say, in order to make an induction motor work as a motor above synchronism its secondary winding should not itself generate its current, but a current has to be let into it against its own electro-motive force. This is exactly what happens in one motor here as we have pointed out that the four-pole side acts as a generator and then, of course, the electro-motive force from the ten-pole rotor acts as a counter-electro-motive force.

On account of this we find that also with this connection the motor will act as a motor with $10 - 4 = 6$ poles just the same, but that it will not by itself get up to the right speed, but has to be speeded up by some outside force.

Having now described the methods of the differential concatenation in combination with the direct one the next question is this: What advantage can be derived from this arrangement for railway work. Immediately it will be clear to a student of these matters that one advantage of an important nature is the possibility of using economically four different speeds instead of two. (As a matter of fact the method of getting three different speeds has been known for some time, but so far as the writer is aware it has not yet been used for traction purposes.) When running over a road with considerable grades we now have the possibility of working the motors at different torques corresponding to the different speeds and still have the same output of the motors, *i. e.*, a practically constant current. As is well known, this is not the case with the series motor. When this motor increases its speed, not only the torque but also the output becomes less, and can be increased only by cutting out part of the field, an arrangement which is less satisfactory as it often causes a liability of sparking. With the methods described above on the contrary it is possible over almost the whole range to increase the torque above the normal, if that should be considered desirable—for instance, in order to make up for lost time. This is shown graphically in Fig. 4, which shows a curve of

torque and speed for a series motor and for a combination of polyphase motors. While the direct-current motor can not at higher speeds develop torque above the curve "on loop," the alternating-current motors can at will momentary develop anything up to the dotted line. When using this system the task of the motorman will consist only in handling the controller so as to keep the current at a certain normal value, not only when accelerating but also when running.

There is, however, one question more, and which is really fully as important as those already dealt with, *viz.*, how is the economy in starting. This is the vital point for a considerable part of traction work projected just now. In order to see the result of the three and four-speed arrangements in this direction, it is necessary to choose special cases—different combinations giving different economy. As an example, take for the four-speed system two motors, one giving 2.5 times the speed of the other; for the three-speed arrangement, two motors, one giving fifty per cent more speed than the other, and compare the results of these combinations with the regular concatenated connection of two similar motors with the single motor and the direct-current series motor as to economy in starting. In order to find the relative economy we shall first consider the loss in secondary resistance outside the motors, that is to say, the loss if there were no losses in the motors themselves. When such an induction motor is brought up to full speed from standing still and with a constant torque, the input is exactly twice the output, that is to say, the loss in secondary resistance is equal to the amount of useful work. Generally, if an induction motor with no losses in itself be brought up from a speed equals n up to full speed equals 1 with constant torque the ratio of input to output is $= 2/n + 1$.

Applying this formula to the different cases we find, if the useful work is unity, the input in electrical energy in the different cases:

1 : *o* The single motor $2/0 + 1 \cdot 1 = 2$.

2 : *o* Two similar motors; concatenated connection used up to half of normal speed: Energy developed by motor up to half speed $= \frac{1}{4}$; accordingly

$$\frac{2}{0+1} \times \tfrac{1}{4} + \frac{2}{0.5+1} \times \tfrac{3}{4} = 1\tfrac{1}{2}$$

3 : *o* Two motors with relative speeds 1 : 1.5; giving three speeds 0.4 : 0.667 : 1. Energy stored up at these three speeds $= 0.16 : 0.444 : 1$ accordingly

$$\frac{2}{0+1} \times 0.16 + \frac{2}{\frac{0.4}{0.67}+1} \times (0.444 - 0.16) + \frac{2}{0.67+1} \times (-0.444) =$$

$$0.32 + 0.355 + 0.667 = 1.342.$$

4 : *o* Two motors with relative speeds 1 : 2.5 giving four speeds $= 0.286 : 0.4 : 0.677 : 1$. Energies corresponding to these speeds $= 0.082 : 0.16 : 0.444 : 1$.

Input accordingly

$$= \frac{2}{0+1} \times 0.082 + \frac{2}{\frac{0.286}{0.4}+1} \times (0.16 - 0.082) + \frac{2}{\frac{0.4}{0.67}+1} \times (0.444 - 0.16) + \frac{2}{0.67+1} (1 - 0.444) = 0.164 + 0.091 + 0.355 + 0.667 = 1.277.$$

In order to compare these results with the economy in starting with direct-current motors we assume a series motor having no losses in itself; then the economy, when starting, is depending on at what lowest speed we can obtain the full counter electro-motive force. An assumption which corresponds fairly well to regular good engineering is, that the full electro-motive force is reached at a speed of two-thirds to three-quarters of the full speed. When connecting the motors in series this will accordingly correspond to a speed of one-third or three-eighths of full speed when the changing over from series to connection to parallel is accomplished. Using the same formula as before, which is here equally applicable, we find input in electrical energy in order to obtain a useful work of unity:

2 : *o* Full voltage rendered by the motors at $\frac{2}{3}$ of full speed.

Energy required $=$

$$\frac{2}{0+1} \times \frac{1}{9} + \frac{2}{0.333+1} \times \left(\frac{4}{9} - \frac{1}{9}\right) + \left(1 - \frac{4}{9}\right) =$$

$$0.222 + 0.444 + 0.555 = 1.222.$$

2 : *o* Full voltage rendered by the motors at $\frac{3}{4}$ of full speed. Energy required $=$

$$\frac{2}{0+1} \times \frac{9}{64} + \frac{2}{\frac{0.375}{0.75}+1} \times \left(\frac{9}{16} - \frac{9}{64}\right) + \left(1 - \frac{9}{16}\right)$$

$$0.281 + 0.562 + 0.437 = 1.281.$$

Comparing these results we find that neglecting the losses in the motors themselves, the economy in starting, when using the combination of direct and differential concatenated connection, can be made very nearly the same as in direct-current work, and that the three-speed concatenated connection gives an input of something like six to seven per cent more, the regular concatenated connection with two similar motors an input of about twenty per cent more than the direct-current and four-speed alternating system and finally the single alternating motor an input of about seventy-five per cent more. Now taking into consideration the losses of the motors themselves in order to get a really fair comparison of the relative merits we may assume the efficiency of the series motor and an induction motor at full load the same; say ninety-two per cent—the efficiency of two motors in concatenation will then come to something like eighty-two per cent (or even eighty-four with a low periodicity, say twenty-five cycles); let us, however, assume only eighty-two per cent. If this is taken into consideration and the time during which the motors work with their different efficiencies, in different connections is also considered, we get the following results:

Electrical energy for obtaining unity useful work in starting up to full speed

1 : *o* The simple alternating motor 2.17.

2 : *o* Two similar motors: concatenated connection used up to half of normal speed $= 1.72$.

2 : *o* Two motors with relative speeds 1 : 1.5, giving three speeds: 0.4 0.667 : 1 $= 1.51$.

4 : *o* Two motors with relative speeds 1 : 2.5, giving four speeds: $0.286 : 0.4 : 0.667 : 1 = 1.45$.

5 : *o* Continuous-current series motors operating in series up to $\frac{1}{3}$ of full speed and resistance entirely cut out at $\frac{2}{3}$ of full speed $= 1.33$.

6 : *o* Continuous-current series motors operating in series up to $\frac{3}{8}$ of full speed and resistance entirely cut out at $\frac{3}{4}$ of full speed $= 1.4$.

In these calculations some factors of minor importance are neglected. Considering for instance the iron losses in the secondary of the induction motors when accelerating would make the figures slightly more favorable to the direct-current series motors. On the contrary, it should be observed that there is an approximation in favor of the series motor to assume that connected in series they get up to fully half of the speed, when connected in multiple with same current. These approximations, however, will cause very small influence on the results obtained.

Now, taking into consideration the energy which can be returned to the line by means of alternating-current motors it is evident that also in this respect an advantage is obtained over the simple concatenated connection.

Taking the three-speed combination we find it possible to brake electrically and return energy to about 0.43 of the full speed and with the four-speed combination down to about 0.31 of the same.

Theoretically it would be possible, when braking electrically, with the three and four-speed arrangements to do it in steps, but as this would mean a slower stopping, reference is here only made to applying at once the full braking torque corresponding to the concatenation giving the smallest speed.

1:*o* Single motor—no energy.

2:*o* Two similar motors.

Braking down to about 0.54 speed. Energy restored when braking from speed $= n$ down to the least possible $= n_1$ with that connection $= 2\ n_1/n_1 + n \times$ efficiency of motor acting as generator $\times$ energy taken from moving masses.

When using motors in concatenation for braking it must be borne in mind that it is not possible to obtain a negative torque until the speed has come down to a certain percentage of the full speed. This percentage is dependent on the resistances of the conductors and may vary considerably. For the purpose of getting a comparison it is here assumed that the electrical braking can begin at a speed of 0.9 of the synchronous speed.

In this case, energy accordingly is taken from moving masses from 0.9 down to 0.54 of full speed. Accordingly if efficiency be taken equals 0.82

$$\frac{2.0.54}{(0.81 - 0.29) \times 0.54 + 0.9 \times 0.82 = 0.32}$$

3:*o* Three-speed motors as before. When braking connect immediately in concatenation so as to be able to use the same connection down to 0.43 of full speed.

Energy restored =

$$\frac{2.0.43}{(0.81 - 0.183) \times 0.43 + 0.9 \times 0.82 = 0.33}$$

4:*o* Four-speed motors as before. When braking connect directly for being able to brake down to a speed of 0.31 of full speed.

Energy restored =

$$\frac{2.0.31}{(0.81 - 0.096) \times 0.31 + 0.9 \times 0.82 = 0.3}$$

The results so far obtained would correspond to reality in such cases where gearing is not made use of; if gearing is used, the loss therein should be taken into consideration. This loss can generally be estimated at about five per cent; it must, however, be borne in mind that in the case of differential concatenation it may amount to somewhat more, since the power transmitted through the gearing really is more than the resultant power. In the table below, where the results are brought together, this increased loss is, however, neglected. The table gives a comparison of the different systems as to input, the motors for starting up to full speed and electrically braking down as far as possible.

RELATIVE AMOUNT OF ENERGY CONSUMED.

	Accelerating only.		Accelerating and Electrically Braking.	
	Without Gearing	With Gearing.	Without Gearing.	With Gearing.
D. C. motor, resistance entirely cut out at ⅔ full speed	1.33	1 4	1.33	1.4
D. C. motor, resistance entirely cut out at ¾ full speed	1.4	1.48	1.4	1.48
A. C. motor, simple	2.17	2.29	2.17	2.29
A. C. motors regular concatenated connection	1.68	1.77	1.36	1.47
A. C. motors, three speeds: 0.4 : 0.67 : 1	1.5	1.58	1.17	1.27
A. C. motors, four speeds: 0.25 : 0.4 : 0.67 : 1	1.45	1.52	1.15	1.24

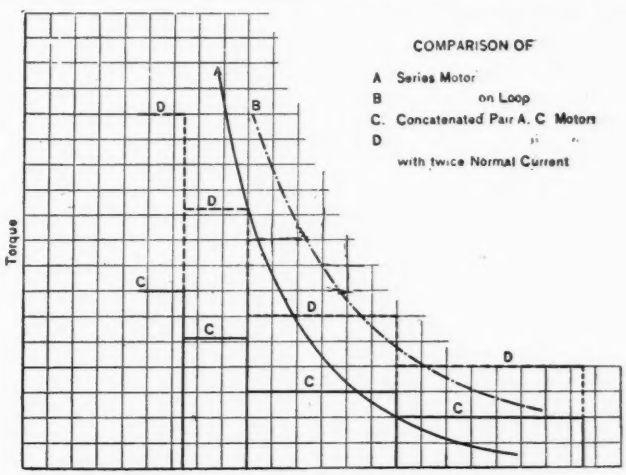


FIG. 4.

Admitting that the polyphase motor, as a rule, is fully as efficient as the series direct-current motor, it may be considered that when working on an even road the difference in energy consumption will be negligible, then it would appear that by using the four-speed arrangements of concatenated connection it would be possible to get a more economical method of working electric roads than by means of the direct-current system with series motors. Considering at the same time that for greater distances the electric energy has to be generated as alternating current and then transformed into direct in converter stations, whereas with polyphase motors on the cars simply static transformers can be used, giving a difference in loss of at least five to seven per cent in favor of the alternating-current motors, the comparison comes out still more in favor of these. An advantage also for them is that there is no need for high voltage in the rotating parts of the motors; the rotor windings can be arranged for any desired voltage, thus giving the designer full liberty to choose this so as to get the most convenient winding.

The author is fully aware of the drawbacks inherent to the alternating system such as the necessity of using a double trolley—the lag, etc., and admits that in many cases this system is entirely out of question, for instance, only on account of the double trolley, but for elevated roads and for underground work this matter hardly comes into consideration, and in many other cases the drawbacks of the alternating system will probably be more than outbalanced by its greater economy.

One thing more should be mentioned. Probably it will be pointed out that there will be difficulties introduced by making one of the motors of 2.5 times the torque of the other. To this the author would reply that the best solution probably in many cases will be to connect in concatenation one motor with two or three others in parallel—for instance, with a locomotive with four axles, have three of the motors of a slower running type than the fourth, and of a current-carrying capacity something like one-third of this one. The same arrangement could be used for an ordinary double-truck car with four motors. For cars with only two axles the best arrangement will probably be with only three-speed connection, and then there will be very little difficulty, the difference in torque of the two motors not being so considerable.

WHAT IS THE BEST METHOD OF CARING FOR CONSUMERS' COMPLAINTS.*

BY IRVIN BUTTERWORTH.

The manager of the Denver Gas and Electric Company is convinced that no time or money is spent to better advantage in the conduct of a gas or electric lighting business than that devoted to the giving of prompt, thorough and satisfactory attention to all complaints and requests received from consumers. In the case of a quasi-public corporation, popularity is almost synonymous with prosperity, and nothing contributes more to the former than the patient hearing of customers' complaints and requests, and prompt and careful attention thereto. It is said that the Chinese offer sacrifices to the devil because the Lord is already on their side, and on a similar theory an hour spent in trying to satisfy one disgruntled consumer is a much better use of time than devoting it to the entertainment of customers who are already friendly. The manager of a gas or electric light company must also bear in mind the naturally hostile attitude of the average citizen toward quasi-public corporations, and nothing can so quickly establish cordial relations between a company and the community as painstaking and courteous treatment of each individual consumer, however unreasonable, or however small his consumption. Each consumer, however small or obscure, has a certain influence on a certain element in the community, and to send him forth with a good feeling toward the company and talking well of it among his friends, is surely worth the time and effort required to put him in this frame of mind. There is a wide difference, measured in its effect upon the company's welfare, between the extremes of abuse and praise on the part of even its humblest and most unreasonable customer. The greatest prosperity and the smoothest sailing will be found to lie along the line of best individual treatment of customers, irrespective of the price and quality of the product supplied, and no manager should rest easy so long as he knows there is a single dissatisfied customer on his company's books. The writer recently devoted an hour of his time, together with that of his chief complaint clerk, to satisfying the doubts of one of our most obscure and least influential customers whose bills did not average $1 per month, and we consider that our time was well spent.

In carrying out in practice the foregoing theory, the Denver Gas and Electric Company has in operation a very complete system for receiving, recording and attending to complaints and requests received from its customers, which we regard as one of the most important "bureaus" of our office. It is in personal charge of what we call our "order clerk," whose sole duty is to receive complaints and requests from customers and have them promptly and satisfactorily attended to. He is designated as "order clerk" rather than complaint clerk, and the sign over his window reads "Orders" rather than complaints, because, while we encourage customers to make their complaints known, we want each one to think that his is the only complaint made. It certainly does not help a company's reputation for careful and accurate work and fair dealing to have it known and advertised that a special department must needs be maintained for taking care of complaints; nor does it lessen the customer's real or imaginary grievance when he comes to the office to protest, for instance, against the size of his bill and finds that so many others are suffering from the same injustice (?) that the company has found it necessary to establish a separate department, with a special corps of clerks, for attending to them.

The consumer, therefore, who appears at our office to enter a complaint or request, is politely shown to the "order window," which is conspicuously labeled and prominently located. If space would permit, the order clerk would be provided with a separate and closed room in which all complaining customers could be received and seated, and thus be treated with a degree of courtesy and consideration that would of itself have a mollifying effect; while, at the same time, other customers waiting outside or attending to other business at adjacent windows, particularly new applicants for service, would not overhear the making of complaints, accompanied, as they sometimes are, by tirades against the company.

All complaints received at the office, personally, or by telephone or mail, are referred at once to our order clerk, who enters them in a large book so ruled as to show the reference number of the complaint and date and hour of its receipt, the name and address of complaint, the character of the complaint, the name of the employé sent to remedy it, the time such employé is sent, the time the complaint is reported as remedied and the work done in remedying it. An order is then immediately filled out, corresponding to the entries in the book, and turned over to the shop force for prompt attention. In urgent cases the complaint is telephoned to the shop for immediate attention, followed by a confirming order. When the workman has attended to and remedied the complaint, and while he is still at the premises of the complainant, he fills out the remaining blanks on the order, showing the cause of the trouble, his method of remedying same, the date and his own name, and secures the signature, at the bottom of the order, of the complainant, or of a responsible member of his family, certifying that satisfactory attention has been given. The order is then returned to the order clerk, who enters the facts on his record book, above described. He then fills out and mails to the complainant a return postal card, worded as follows: "On....., 1902, you reported.....Kindly fill out this return postal card stating whether the matter has been attended to to your entire satisfaction. Your prompt reply will be greatly appreciated. Very truly yours, The Denver Gas and Electric Company." The reference number is put on each of these cards before sending them out, in order that responses not signed may be identified, and those that are returned are checked off on the record book. Of course many of the cards are not returned, but many of them are; and most of these report the trouble to have been satisfactorily remedied, many of them expressing thanks and appreciation. Occasionally one comes back with the statement that the trouble still exists or has not been satisfactorily attended to. In such cases a second order is made out and sent to the shop for immediate attention, with proper caution to the workman taking the order. The returned postal card is then attached to the original order, and after the second order comes back with the notation that the trouble has been remedied, the workman that attended to the original one is called upon by the order clerk to explain his failure to have properly remedied the trouble. Occasionally such a derelict workman is brought on the manager's carpet and properly disciplined for his remissness. In this way each man knows that his work is under the review of the management, and a high degree of efficiency on the part of the workmen has thus been developed. It is, of course, the duty of the record clerk to see that a report is turned in within a reasonable time on every order that is sent out for attention.

The system of entering in chronological and numerical order the details of each complaint and request, and the attention it receives, enables us, among other things, to refute satisfactorily such statements as "I telephoned you last month to come out and re-read my meter, but you never did it;" but the best feature of the system is the sending of the return postal card, which almost invariably pleases the customer and creates the desired impression in his mind that the company is, after all, interested in giving him good service and values his patronage.

*Read before the National Electric Light Association at its twenty-fifth convention held at Cincinnati, Ohio, May 20, 21 and 22, 1902.

ARE FREE LAMP RENEWALS DESIRABLE?*

BY JAMES ENGLISH, F. ELLWOOD SMITH, F. W. LITTLE AND W. J. GREENE.

J. ENGLISH.

Fifteen years ago, after a careful consideration of this problem as it affected those companies that I was managing, and after some experimenting with the other method of charging for renewals, we adopted the plan of free renewals and have found it beneficial and wise.

We found that when the customer paid for his renewals a large portion of them would burn the lamps until they were "black in the face;" that renewals would only be made by them, practically, when the lamps broke. This resulted in extremely poor lighting service. We could devise no way to induce the user to renew his lamps with even reasonable frequency as long as he had to pay anything for the lamp, but that he would let the lamps burn until they broke, and complain to us that our service was poor. It was very evident that we could not expect to render satisfactory service under such conditions, and unless our service was good other illuminants would take its place.

A short experience in renewing lamps demonstrated the fact that if we were to do this work advantageously some definite system should be employed. The necessities of such a system seem to be that:

First—Lamps should be renewed often enough to ensure the lamps in service maintaining a given candle-power during that service, or a limitation in fall of candle-power.

Second—The renewals should be made in such a manner as to cause no annoyance to the user.

Third—Renewals should be made often enough to obviate, practically, the necessity for customers ever calling for new lamps to replace those burned out.

Fourth—The system adopted should be one that would effect the desired end in the most economical manner to the company.

Referring to the first requirements, we determined that a variation of two candles during the use of the lamp was as large as would furnish satisfactory service. Testing soon demonstrated the fact that with three and one-half-watt lamps we could not get an average burning of over 400 hours and keep the lamp within the above limits. In the early days we did not in practice obtain such good results, but with the gradual improvement in the lamp we have reached a point where each and every lamp we put out can be relied upon to maintain its light within the limit. Starting at sixteen candle-power they will all be at least fourteen candle-power after 400 hours' burning.

We therefore adopted a principle that all lamps on our circuits should be changed once in 400 hours. It was quite clear that with a widely varying character of service if we changed uniformly all lamps at a given date we should remove many that had burned but a few hours and were good for many hours longer. It was equally plain that we could not assort these lamps in the places of installation, but we could bring all of them into the station and then sort them by a photometer, discarding all lamps that were not sixteen candle-power and putting in stock, to go out again, all that were sixteen candle-power. This method we have followed in our different stations for over seven years. We change every lamp on our mains four times per year, usually in February, May, August and November. We find that this results in very few lamps having been used over 400 hours. We find that forty per cent of the lamps we have changed and brought in are sixteen candle-power, and all right to go out again.

The results of this method have been fine, and the experience of ten years has demonstrated:

First—That all our lamps while in service are at least fourteen candle-power, or not at any time during their service more than two candles below the initial candle-power.

Second—This method delights the users, who feel they are really getting something for nothing. That we no longer have occasion to send out lamps between periods of changes, and rarely hear of a broken lamp.

Third—That the cost to the company of this method is at least no greater than that of the ordinary method of making free renewals.

Fourth—That the general effect on our business has been remarkably satisfactory; that our lighting is good, better than any I have ever had occasion to examine.

Fifth—That we have now passed beyond the point of complaints of service, so much so that we rarely see or hear from a user, unless it be on the question of rates.

Generally, therefore, I have not the slightest hesitation in saying that in my opinion no electric lighting company can afford to do business in the old ways, and that the sooner lighting companies recognize the inherent weakness of the incandescent lamp itself, and devote their energies to attempting to obviate the ill effects of this fault on the business, the more successful they will be.

F. ELLWOOD SMITH.

I used to believe that a lighting company, whether it were a gas company or an electric light company, should own nothing whatever inside of a customer's building except the meter; that the customer should provide all the necessary shut-offs, pipes or wires, the fixtures, and the gas burners or the electric lamps. The business of a gas company being to furnish gas and that of an electric company being to furnish electricity, I claimed that the company's responsibility ceased when it had delivered the goods of proper quality and quantity at the meter. Theoretically, this may be true, but practically it is not the best method. If customers use arc lamps it is almost necessary that the company furnish and care for the lamps, and I think that all electric light managers are agreed on this point. In the matter of furnishing incandescent lamps, however, there is a difference of opinion, and incandescent lamps are furnished on a number of plans.

In my own experience, for a number of years I required my customers to buy all their lamps, either from our company at cost, or elsewhere if they saw fit. They usually saw fit to buy elsewhere, getting an inferior lamp for less money, or not buying at all, and thus not using the electricity. To the average customer all incandescent lamps are alike, except that some are marked sixteen candle-power and others twenty-four candle-power, eight candle-power, etc. The customers know and care nothing about voltage and efficiency. I have found lamps used on our circuits consuming five watts per candle-power, and the customer thought he was getting a bargain when he bought this lamp for fifteen cents instead of paying us twenty cents for one of our lamps, which would consume only 3.1 watts per candle-power. Many a time I have found 110-volt lamps on our 104-volt circuit and customers finding fault with us because they did not get a good light. When customers have to pay for new lamps they will use the old lamps just as long as they will burn, and if one lamp does not give light enough, two must be used, and then the bill is large and the customer has a double kick coming to the company—the light is dim and the bill is large. Under such conditions the frequent result is a

*Read before the National Electric Light Association at its twenty-fifth convention, held at Cincinnati, Ohio, May 20, 21 and 22, 1902.

notice to the company to discontinue the service.

Several years ago I retained a number of customers that were dissatisfied, by simply giving them a few new lamps and proving to them that the trouble was in the lamp and not with the current. The results were so satisfactory in such cases that I was obliged to become converted to the free-renewal belief and to give my customers a new lamp for every old lamp returned. It is impossible to educate customers so that they will buy good lamps when needed, and, therefore, in order to give good service the company must take the matter into its own hands and give free renewals.

The cost of the lamps is a necessary expense, just as much so as is fuel. A customer using a dim lamp of, say, twelve candle-power, is paying for, say, thirty-seven watts. You give him a new lamp giving sixteen candle-power and consuming, say, fifty watts, and he will be satisfied with the light and willing to pay for the additional current. You will very soon get back the cost of the lamp and get an increased revenue and a satisfied customer. I urge our customers to change their lamps often, and if a lamp is dim to remove it. This request is printed on every monthly bill. We do not give new lamps in exchange for broken lamps, and exchange free only eight-candle-power, sixteen-candle-power and twenty-four-candle-power lamps. We sell new lamps of these candle-powers to our customers at ten cents each. We will get for our customers any other style of lamp and charge them the actual cost to us.

I have not adopted the method of sending men to the customer's house and replacing his lamps, but I try to keep the dim lamps weeded out by circulars and notices on the monthly bills. This plan works fairly well, and I do not often have complaint of dim lights. I confess, however, to believing that a periodical systematic renewal of lamps on the circuits is a very good thing.

All lamps returned are photometered, and if of sufficient candle-power are put into stock to be used again. We retain those giving fourteen candle-power, and use them near the centre of distribution, where the voltage is a little greater.

I do not believe in furnishing free the first installation of lamps, especially in residences, because in a great many instances the return per lamp will be very small, and I believe that the cost of the first lamps will not keep away any desirable customers. I believe that every company furnishing electric current for incandescent lighting ought, for its own good, to furnish free incandescent lamp renewals.

F. W. LITTLE.

The question of free-lamp renewals has been but lately considered by the Peoria Gas and Electric Company, and we have had no opportunity to observe the results of such a policy in this community. The supply business of this city has been carried on entirely by the local supply companies under a general understanding that we would not interfere in their territory further than selling incandescent lamps at practically cost.

Our rates for electric current are very low, being limited by the terms of the ordinance under which we are working to ten cents per kilowatt-hour as a maximum.

During the last three years we have entirely remodeled our generating plant and distributing system, entailing a large expense, and requiring a change of voltage of our secondaries from 52 to 104 volts, thus necessitating a change in consumer's lamps. This was done by an exchange on the basis of a charge of twenty cents for each new 104-volt lamp, and an allowance of ten cents for each fifty-two-volt lamp replaced. This resulted in bringing up the incandescent lamps on our system to a very good standard at a low cost to the consumer.

The above conditions have delayed our making any reduction in the selling price of lamps. We are now, however, considering selling lamps at cost and renewals at a nominal price where consumers turn in burned-out lamps of the brand we handle. We believe this will ensure the use of first-class lamps on our circuits and the freer use of current, due to the low cost of the lamps, without entirely cutting off the revenue from lamp sales. If results indicate that the step is unprofitable, the loss will not be as serious as if we furnished free renewals; while if results indicate that a further reduction in the price of lamps would be advantageous, we are in favorable position to make it. The renewal of lamps at a low cost, or free of cost, to the consumer must be considered largely as an advertisement and a talking point in favor of the use of electric current in preference to other forms of light. But where established rates for current are such that concessions must be carefully counted before being allowed, we think it good policy to make each concession count for as much as possible.

W. J. GREENE.

From 1888 to 1893 free-lamp renewals were furnished by us. In 1892 it became evident that the net earnings were not keeping proper pace with the growth of the plant and the increased investment. In 1893 this condition became critical, and a change of some kind became imperative. Two reforms were instituted—one, the adoption of a minimum charge proportional to the maximum-burning lamps; the other, the discontinuance of free-lamp renewals. The desired results followed. These changes were soon followed by the adoption of a two-rate system in connection with the minimum charge, so that consumers upon whom fell the heavier cost of lamp renewals were many times compensated for such expense by the lower cost of service.

The reasons originally advanced in favor of charging for lamp renewals were:

First—Reduction in operating expenses.

Second—Consumers had been accustomed to maintaining equipments in all other methods of lighting, except arc lamps, and this company considered lamp renewals a legitimate expense to be borne by consumers. Nearly all of our customers concurred in this view.

The reasons for continuing present arrangements until such time as local conditions may make desirable the furnishing of free-lamp renewals, are:

First—The rapid increase of business, in the face of hard competition with gas, being difficult to provide for with increased capacity, owing to manufacturing delays and engineering difficulties, makes any check to growth, as may result from charging for lamp renewals, desirable.

Second—Lack of facilities, under present office arrangements, to carry a supply of lamps and conveniently serve consumers with lamps from the office. Lamps, supplies and construction work are furnished by local supply houses which are, on the whole, furnishing consumers with a good lamp at figures slightly in advance of cost.

Third—Advantages accruing to supply houses from handling lamps and the better service they can render us in return.

Fourth—Avoidance of the extra time required on the part of the management, and extra cost of rental for storage room, labor and lamps.

In a recent United States patent it is stated that the amount of arsenic to be used in brass casting varies between 0.001 per cent to about 0.25 per cent, although the latter amount is for extreme cases. An alloy consisting of about sixty-three per cent of copper and thirty-seven per cent of zinc is said to be excellent, practically perfect results being obtained by using about 0.05 per cent of arsenic.

WHAT EFFICIENCY LAMP SHOULD BE USED, AND HOW MAY THIS EFFICIENCY BE DETERMINED FOR ANY PARTICULAR STATION?*

A DISCUSSION BY HENRY L. DOHERTY, SAMUEL E. DOANE, L. G. VAN NESS AND FRANCIS W. WILCOX.

New York, March 7, 1902.

MR. S. E. DOANE, Marlborough, Mass.

DEAR SIR—The National Electric Light Association has departed somewhat from its usual programme methods, to the extent of substituting for papers written discussions of certain subjects considered of great importance to the various central station managers. One of the subjects selected is, "What Efficiency Lamp Should Be Used, and How May This Efficiency Be Determined for Any Particular Station?"

My own views are that the efficiency of the lamp, assuming that we are using as a standard a lamp of sixteen candle-power, should be placed at that point where cost to the central station for the supply of current just balances the cost of lamp renewals, and that when this point has been determined for a sixteen-candle-power lamp, then all the other-sized lamps should have an efficiency that would bring the cost of lamp renewals to the same point per kilowatt-hour consumed. In other words, when lamp renewals for any given efficiency lamp cost any more than it would cost the central station to supply additional current to yield the same amount of light from a lamp of lower efficiency, they should adopt this lower-efficiency lamp.

I do not think our rate of charges to the consumer should be considered at all except that we can afford to make a reduction in rate for the lower-efficiency lamps used. The only cost I see to the electric company in using lower-efficiency lamps would be boiler fuel and boiler-room labor, and costs incidental to a larger equipment. Boilers, engines, dynamos, conductors and transformers would have to be increased, and this would add additional costs for interest, taxes and depreciation on this increased investment.

HENRY L. DOHERTY, President.

Marlborough, Mass., April 2, 1902.

MR. HENRY L. DOHERTY,
President National Electric Light Association.

DEAR SIR—In accordance with your letter of the eleventh ultimo, I have tried to find some points of difference, but I can't see that we can differ at all. You have put the whole matter so clearly that all I shall attempt to do will be to point out some facts that may or may not be in your possession. If not, they will be of use to you.

Of course, as you say, the cost of a lamp to a station includes the cost of the power it consumes during its life.

I was told not long ago by a station manager that he preferred to use 3.5-watt lamps as his station was loaded now; he could not get any more equipment, as considerable outlay would be necessary to extend the station for it and the money for this could not be conveniently procured.

He must also hold up his income, and he was in business to sell current. He was selling all he made, and any pressure that would be brought to bear to reduce customers' rates would be in the nature of a demand to sell current as cheaply as some neighboring town, without regard to whether the monthly bills were lower or otherwise. He said he was prepared to burn 3.1-watt lamps as soon as his increasing load—increase that he could not avoid—overloaded his apparatus dangerously. He said he would increase his expenses by using 3.1-watt lamps, and would not increase his income.

That was the other view of the matter. This view is what I used to combat.

You evidently believe it pays to furnish a man with his light at as low a figure as is consistent with good business profit, and to do a large business. So do I.

Any central station man can say: "If I burn a lamp in this socket continuously for a year it will cost me so much for energy and so much for renewals," including in the first all charges for all purposes except the actual cost of the lamp, cost of freight on them, photometer work, etc., and including in the latter the cost of the lamp, etc.

By making three columns and heading one 3.1 watts per candle, the second 3.5 watts per candle and the third four watts per candle, it would not take long to find out which was cheapest.

To facilitate such an operation, here are some figures:

100 TO 130 VOLTS.

Candles	Life to 30 per cent Initial Candles			Ultimate Life		
	3.1-wpc	3.5-wpc	4-wcp	3.1-wpc	3.5-wpc	4-wpc
8	....	175	400	....	210	500
10	....	185	425	....	230	550
12½	95	195	380	120	250	450
16	100	175	340	130	210	375
19	90	150	340	120	165	340
24	80	150	320	110	225	340
32	80	140	300	100	225	340
50	70	120	280	100	170	....

These percentages in round figures are approximately accurate, and will hold under any reasonable conditions of lamp quality and voltage variation so long as the 3.1-watt lamp is taken as a basis.

I say this because any maker that can make a 3.1-watt lamp that will meet his guarantees, will have no trouble with those of 3.5 and four watts.

S. E. DOANE.

BY L. G. VAN NESS.

For the purpose of these calculations I will assume: That sixteen-candle-power lamps only are to be considered; that the life of lamps on perfect regulation is, for 3.1-watt lamp, 420 hours; for 3.5-watt lamp, 750 hours, and for four-watt lamp, 1,500 hours; that lamps will be changed periodically by the company, and these changes made often enough so that lamps burned until midnight will not exceed their normal light.

The most desirable efficiency of lamps will then be determined by:

First—The average regulation of the circuits.

Second—The generating costs that are strictly proportional to output.

Third—Investment per kilowatt capacity of the station.

Fourth—The average consumption per lamp per year.

Fifth—The charge per kilowatt-hour to consumer.

AVERAGE REGULATION OF THE CIRCUITS.

I have taken as the first consideration the average regulation, as that determines the life of the lamp; therefore, the cost of lamps per kilowatt-hour sold. With perfect regulation, the life of lamps is fairly well determined; but as none of us can claim perfect regulation, we are obliged to assume the degree of perfection, and accept the claims of the manufacturers as to the life of lamps under variable voltage. The manufacturers nearly all agree that an excess voltage of one per cent will reduce the life of lamps to about eighty-eight per cent of the normal. Beyond this point there is a wide difference of opinion, and I know of no independent tests to guide us in assuming the life of lamps at excess voltage. I will assume, therefore, that if our regulation is so bad as to be equivalent to an excess voltage of over one per cent, we should devote our attention to the improvement of the regulation, and postpone the question of lamp renewals temporarily.

We have very few data at hand from which to determine the average cost of

*Read before the National Electric Light Association at its twenty-fifth convention, held at Cincinnati, Ohio, May 20, 21 and 22, 1902.

testing and renewing lamps, but from the information available, I should estimate it at one and one-half cents per lamp renewed. With lamps at sixteen cents each, our costs per kilowatt-hour for lamps and for renewing would be as follows, for perfectly regulated circuits:

Life.	Period of Renewal.	Cost of Lamp per Kw. Hour.	Cost of Renewing per Kw. Hour.	Total Cost per Kw. Hour.
3.1-watt 420 hours.	70 days	.76	.071	.831
3.5 " 750 "	125 "	.38	.036	.416
4 " 1,500 "	250 "	.164	.016	.18

With regulation equivalent to an excess of voltage of one per cent, they become:

Life.	Period of Renewal.	Cost of Lamp per Kw. Hour.	Cost of Renewing per Kw. Hour.	Total Cost per Kw. Hour.
3.1-watt 370 hours.	61 days	.366	.081	.947
3.5 " 660 "	110 "	.433	.04	.473
4 " 1,320 "	220 "	.189	.018	.207

GENERATING UNITS THAT ARE STRICTLY PROPORTIONAL TO OUTPUT.

These costs affect the lamp efficiency, inasmuch as they are the only operating costs that are increased by substituting low-efficiency lamps for those of higher efficiency. The question is to determine the costs that are strictly proportional to output.

Boiler fuel is practically the only item that varies with the output.

Boiler-room labor would vary nearly in proportion to the output if we considered large stations only; with smaller stations the item changes but slightly with changes of load.

Engine and dynamo labor is affected slightly in large stations and practically not at all in smaller ones.

Dynamo and engine repairs are affected to some extent, but the items are not large compared with the total expense. The remaining items may be considered constant with the small changes we should make by changing the efficiency of lamps. We can not be greatly in error if we assume that the fixed portion of boiler-room labor is equivalent to the variable portion of the other expense. We will therefore consider boiler fuel and boiler-room labor as strictly proportional to output, with which we will calculate the cost of extra current for lower-efficiency lamps.

INVESTMENT PER KILOWATT CAPACITY.

If we substitute lamps of lower efficiency for lamps in service, we must provide additional capacity for the additional demand; then we must charge against the low-efficiency lamps the cost incurred by the increased investment.

Taxes, interest and depreciation are all the costs that would be affected. Calculating these at twelve per cent on, say, $125 per kilowatt as investment, gives us $15 per year fixed charge per kilowatt capacity of increase.

If we substitute 3.5-watt lamps for 3.1-watt lamps, we must increase our equivalent 12.9 per cent, or for each 7.7 kilowatt, equivalent to 154 lamps, we add one-kilowatt capacity; thus our increased fixed charge would be distributed among the 154 lamps. This is equivalent to nine and three-fourths cents per lamp per year. Substituting four-watt for 3.1-watt lamps, we must increase the equipment twenty-nine per cent; the charge will be distributed among sixty-nine lamps and the fixed cost per lamp per year is twenty-one and three-fourths cents.

Substituting four-watt for 3.5-watt lamps, the equivalent is increased 14.3 per cent and the increased cost is divided among 140 lamps, or the cost per lamp per year is about ten and three-fourths cents.

AVERAGE CONSUMPTION PER LAMP PER YEAR.

The average consumption must be considered, as the last item is a fixed cost per lamp per year. To reduce this to a cost per kilowatt-hour consumed, we must determine how much the lamps are to be burned. The fixed cost per lamp, as calculated above, reduced to cents per kilowatt-hour for various kilowatt-hours' consumption per lamp per year, is as follows:

Consumption per lamp per year kilowatt-hour	20	40	80
Fixed cost to change from 3.1 to 3.5 cents per kilowatt-hour	$0.48	.24	.12
Fixed cost to change from 3.5 to 4 cents per kilowatt-hour	0.54	.26	.13
Fixed cost to change from 3.1 to 4 cents per kilowatt-hour	1.03	.54	.27

It will be seen by inspection that we can much better afford to increase our investment for liberal users of light than we can for consumers using their lamps but a small portion of the time.

CHARGE PER KILOWATT-HOUR TO CONSUMER.

This consideration is more in the nature of a limit to the possibilities. We can not with impunity change from 3.1 to 3.5-watt lamps if our consumers are paying for current on a kilowatt-hour basis, as it will raise their bills approximately 12.9 per cent. This we know will make trouble for all, from the manager to the meter reader. We may change from 3.5 to 3.1-watt lamps, but the effect on the consumer avails us little. We may advertise the fact thoroughly that we have reduced the bills ten per cent and give the same amount of light, yet we know from experience that not more than ninety-nine per cent of our consumers will take our word for it and give us credit for a ten-per-cent reduction. We should get much more credit if we changed from a 3.1 to a 3.5-watt lamp and gave a reduction of ten per cent on the bill, although by doing this we really raised their bills about three per cent.

It is true that we might take on more business by using a more efficient lamp, but we ought to derive considerable benefit to repay us for doing more business for a less net profit.

If we have a combination flat and kilowatt-hour rate, we may change the lamps without materially affecting consumers' bills, provided the kilowatt-hour rate is not too great a portion of the total charge. The ideal combination rate would give us about thirty-three per cent of our income on the kilowatt-hour charge, and an increase of 12.9 on this would mean an increase in the bills of about four per cent, which would scarcely be noticeable. It is evident that we should consider the charge to the consumer for each specific case, but for the sake of simplicity we will eliminate it by assuming that we will give a discount that will exactly balance the increase in the bills that would result if we substituted a lower-efficiency lamp for those in service. Then we may collect our figures for comparison in the following table:

Lamp Bill	Cost of Lamps and Renewals	Increase of Fixed Cost on Basis of Consumption per Lamp per Year of			Cost of Extra Current at 1c.	Total Cost on Basis of Consumption per Lamp per Year of		
		200 Kw. Hr.	400 Kw. Hr.	800 Kw. Hr.		200 Kw. Hr.	400 Kw. Hr.	800 Kw. Hr.
3 1	.947	00	00	00	00	.947	.947	.947
3.5	.473	.48	.24	.12	1.89	1.089	.843	.722
4.0	1.207	1.08	.54	.27	.89	1.577	1.037	.767
					Cost at 1/2c.			
Same as above					000	.947	.947	.947
					.086	1.059	.809	.686
					.218	1.505	.965	.695
					Cost at 1/4c.			
Same as above					000	.947	.947	.947
					.064	1.017	.777	.657
					145	1.432	.892	.622
					Extra Current Furnished by Water Power			
Same as above					000	.947	.947	.947
					000	.958	.713	.593
					000	1.287	.747	.477

I have assumed that we have a regulation that is equivalent to one per cent excess voltage. For a better regulation the cost for lamps and renewals would be decreased, and for a poorer regulation increased.

(To be continued.)

The following constituents are said to make a good aluminum solder: Block tin, twenty-eight pounds; phosphor tin—ten per cent phosphorus—14 pounds; lead, three and one-half pounds, and seven pounds of spelter. All dirt and grease should be carefully cleaned from the surface with benzine, the solder being applied with a copper bit. When the molten solder covers the surface of the metal, it should be scratched through with a wire brush, by which means the oxide is broken and taken up, a quick manipulation being necessary.

The Electric Light Convention.

The Twenty-Fifth Convention of the National Electric Light Association at Cincinnati, Ohio.

[*Special Telegram to the* ELECTRICAL REVIEW.]

TUESDAY'S PROCEEDINGS.

CINCINNATI, May 20—The National Electric Light Association began its sessions this forenoon in this city. There was a large and representative attendance and much interest in the proceedings was shown by the delegates which comprised many of the younger electrical engineers of the country.

The programme was announced for the three days' session as follows:

TUESDAY, MAY 20, 1902.

Meeting of the executive committee, 9 A. M.

(Morning session, 10 o'clock, Convention Hall, International Hotel.)

Annual address by President Doherty.

"Does It Pay to Treat Poles with Creosote, Oil or Other Compounds"—W. E. Moore, Augusta, Ga.

"Performance of the Present 220-Volt Lamp"—Fred W. C. Bailey, Columbus, Ohio.

Report of committee on standard rules for electrical construction and operation.

Question box.

(Afternoon Session, 2 o'clock.)

"Three-Phase *vs.* Two-Phase for City Distribution"—B. A. Behrend, Cincinnati; Chas. F. Scott, Pittsburg.

"Protection of Long-Distance Telephone Transmission Lines"—F. A. C. Perrine, Pittsfield, Mass.; L. Denis, Quebec; P. N. Nunn, Provo, Utah; P. M. Lincoln, Niagara Falls, N. Y.; H. G. Gille, St. Paul, Minn.

"Boiler Firing with Oil"—Jas. W. Warren, Los Angeles, Cal.; H. T. Edgar, El Paso, Tex.

Report of committee on legislation regarding theft of current.

Question box.

WEDNESDAY, MAY 21.

(Morning session, 10 o'clock.)

"The Advantages of Gas Engines"—Chas. H. Williams, Madison, Wis.

"Are Free Lamp Renewals Desirable"—James English, New Haven, Ct.; F. Ellwood Smith, Somerville, Mass.; F. W. Little, Peoria, Ill.; W. J. Greene, Cedar Rapids, Iowa.

"Hot Water *vs.* Steam Heating"—J. F. Porter, Alton, Ill.; P. H. Korst, Janesville, Wis.; C. R. Maunsell, Topeka, Kan.; D. F. McGee, Red Oak, Iowa.

Report of committee on analysis of flue gases.

Report of committee on uniform accounting.

Question box.

(Afternoon session, 2.30 o'clock.)

"What Efficiency Lamp Should Be Used"—Henry L. Doherty; Samuel E. Doane, Marlborough, Mass.; L. G. Van Ness, Denver; Francis W. Willcox, Harrison, N. J.

Report of committee on photometric values of arc lamps—Henry L. Doherty, chairman.

Question box.

(Evening session, 8 o'clock.)

"Display Lighting, Signs and Decorations"—Russell Spaulding, New York.

"Possibilities of Sign and Decorative Lighting"—E. J. McAllister, Newark, N. J.

THURSDAY, MAY 22.

(Morning session, 10 o'clock.)

"Rates"—Henry L. Doherty, Denver; L. A. Ferguson, Chicago; L. R. Wallis, Woburn, Mass.; Ralph J. Patterson, Waterville, Me.; Samuel Scovil, Cleveland, Ohio.

"What Improvement Is Desired in Meters"—Robert Ferris, Monmouth, Ill.; C. A. White, Somerville, Mass.; H. H. Scott, Lincoln, Neb.

Report of committee on amendments to freight classification.

Question box.

(Afternoon session.)

"Are Loose-Leaf Ledgers Desirable for Electric Companies' Records"—G. E. Tripp, Boston; H. H. Fairbanks, Worcester, Mass.; Geo. W. Davenport, Boston; Charles R. Price, New Bedford, Mass.

"What Changes Should Be Made in the Plan of Uniform Accounting"—J. P. Crowley, St. Paul, Minn.

"Caring for Consumers Complaints"—Irvin Butterworth, Denver.

Executive session—Reports, secretary and treasurer, executive committee, committee on amendments to by-laws, committee on legislative policy, election of officers, committee on finance.

The meeting was called to order by President Henry L. Doherty in the assembly room of the Grand Hotel. The attendance was unusually large, the number of delegates present considerably exceeding those in attendance upon the opening session for several years past. Mr. James B. Cahoon acted as secretary.

General Andrew Hickenlooper, president of the Cincinnati Gas and Electric Company, delivered an address of welcome in behalf of his company and the city to the delegates. He said:

It affords me a great pleasure to acknowledge the compliment of being assigned to the agreeable duty of extending on behalf of our citizens and your resident fellow craftsmen a cordial and heartfelt welcome to "the queen city of the west, in her garlands dressed, on the banks of the beautiful river." A city which, within her territorial and tributary limits, embraces a population of nearly a half million people, 200,000 of whom are directly engaged in manufacturing enterprises, turning out every year products valued at $300,000,000, which find their way over twenty centering lines of railways to every section of the habitable globe.

A city that contains the largest soap works, the biggest tannery, the most extensive lithographing establishment, the greatest shoe industries and a larger number of carriage factories than any city in the world.

And last, but by no means least, one of the best equipped and most efficiently managed electric manufacturing plants in this country, which, based upon its past history and phenomenal growth, gives promise in the near future of taking its place in the front rank of the great electrical industries of our country.

From the mere nucleus of a plant, employing but twenty men, in 1896, it has in this brief period of half dozen years grown to the dimensions you will be afforded an opportunity of inspecting, briefly stated, having ultimately a producing capacity of 10,000 kilowatts and employing 8,000 men.

Many of the swiftly revolving presses that reflect the intelligence of the old and new world, as well as the railways of Siberia, the mines of Tasmania, the gold fields of Alaska, the great ocean liners and the stately battleships of our nations are to-day responding to the energy of Bullock dynamos, several of which having a capacity of 3,200 kilowatts, are now in process of construction upon orders from the company I have the honor to represent, thus presenting an impressive illustration of the possibilities of well-applied energy and business ability accomplishing results profitable to its projectors and creditable to the industries they represent.

Not only do we thus point with pride to our various manufacturing enterprises, but take equal pleasure in calling your attention to the beauties of our suburban residence districts, incomparable Zoo Gardens, our music halls, Art Museum, Rookwood Pottery, Cincinnati University, our High School Buildings and other notable structures, the erection of which was made possible by the munificent bequeathals of McMicken, Springer, West, Woodward, Hughes, Cunningham, and other enterprising and public spirited citizens who by such commendable acts have endeared their names to every inhabitant of our city.

To you, gentlemen, who have honored us with your presence, it is unnecessary to say more than to briefly refer to the pleasure we feel in extending this welcome to men who have by their energy, genius and scientific attainments rivaled the accomplishments of Aladdin with whose phenomenal success in the lamp business it is presumed you are all still more or less familiar.

But in order that you may not claim an "exclusive patent" on his business methods, or arrogate to yourselves all the credit for success in changing "new lamps for old ones," I desire to call your special attention to the fact that even in his case it became necessary to enlist the services of two promoting agencies—the "genius of the lamp," which you may properly represent, and the "genius of the ring"—a term not infrequently locally applied to gentlemen like myself who have rendered material assistance in promoting the introduction and utilization of the appliances which your genius has created. It has been said of the immortal Lincoln that for a time "he forged the thoughts that governed the world." You, gentlemen, have not only forged the thoughts but have moulded into practical shape the crude ideas of others which have made possible their application to industrial pursuits and business enterprises that have enriched the world and added materially to the comforts and happiness of mankind. It is not my purpose to weary you with words of fulsome praise, but only to, as briefly as possible, voice the sentiments of all thinking people who recognize the fact that you have established for yourselves reputations for ability, energy, integrity and that type of manhood which marks each and every member of your association as distinctive characters of an age which in scientific accomplishments stands unparalleled in the world's history.

We sincerely hope that this, your twenty-fifth annual meeting, may prove no less enjoyable and professionally profitable than those which have preceded it, and when you have finally exchanged all your new lamps and ideas for our old ones, and leave for your distinct fields of labor, we trust that each and every one may carry with them nought but pleasant memories of your only too brief visit to our city.

President Doherty then read annual address of president, in part, as follows:

It is with great pleasure that I refer to the progress made by this association in recent

years. Our membership has increased rapidly, we are no longer poor and bankrupt, but have a proper income for the support of association, although a larger income would be very welcome and it would enable us to make this association a great factor in development of the central station business, which, after all, is the backbone of entire electrical industry. Not only is our membership growing, but its quality is also improving. We may expect valuable work from our membership, as it possesses untold possibilities, but in some way the necessity must be impressed upon our members of their taking a greater interest in association's work, and feeling a greater responsibility for association progress.

He then discussed at length the programme, methods under which the association might progress, the province of association and the proper attitude toward other associations, the metric system, relationship to manufacturers, municipal and other competition, development of a good market, overhead and underground construction, and advantageous work which might be done by the association.

A committee to consider the address of the president and report upon the recommendations contained in it and appointed was as follows: J. H. Perkins, Youngstown, Ohio; R. S. Kelsch, Montreal, Quebec, and C. E. Hewitt, Elkhart, Ind. A number of letters of regret were read from various gentlemen who were unable to attend the convention, among them being Nicola Tesla, of New York; Professor Elihu Thomson, Lynn, Mass.; George Forbes, London; Professor E. L. Nicholls, of Cornell University; Dean Henry T. Bovey, of McGill University, Montreal; Major-General Robert E. B. Crompton, London; S. W. Stretton, London, and Irving P. Lord, president of the Northwestern Electrical Association.

The meeting then adjourned to the executive session during which a number of matters of importance were considered.

President Doherty stated that he had appointed Mr. J. B. Cahoon secretary and treasurer of the association, and the appointment was ratified by the meeting. Mr. Frederic Nicholls said that he did not think the session should adjourn without placing upon record the esteem and regard which the association had for its late secretary and treasurer, Mr. George F. Porter. During the past years Mr. Porter had done much in upbuilding the association by his efficient and valuable services. Upon a due motion, a vote of thanks to Mr. Porter was passed.

AFTERNOON SESSION.

Upon the reconvening of the session Tuesday afternoon the following gentlemen were appointed to a committee to consider the revision of the by-laws concerning annual dues: Charles L. Edgar, Boston; Frederic Nicholls, Toronto, Ontario, and Charles E. Hay, Springfield, Ill. Mr. W. E. Moore, of Augusta, Ga., then read his paper, entitled "Does It Pay to Creosote Wooden Poles for Electric Line Work?" The discussion was opened by Mr. C. R. Price, and continued by Messrs. R. J. Patterson, A. H. Mainwaring, Robert E. Wyant and Dr. Frederick A. C. Perrine.

A symposium of papers upon the topic, "What Efficiency Lamps Should Be Used, and How May This Efficiency Be Determined for Any Particular Station," was then presented by its authors. This will be found in part on other pages of this issue. In addition to the authors the topic was discussed by Messrs. Arthur Williams, Converse D. Marsh, R. S. Kelsch, Louis H. Ferguson, Calvin W. Rice, A. J. Wurts and the president. There was a protracted discussion between Mr. Ferguson and the president regarding the efficiency of lamps advocated by the latter.

EVENING SESSION.

At the evening session on Tuesday, the interesting subject of "Consumers' Complaints" came up for discussion. A paper was read by Mr. Irving Butterworth which is given in full on another page. A paper, entitled "Are Loose-Leaf Ledgers Desirable for Electric Companies' Records?" was also read, as was a paper, entitled "What Change Should Be Made in the Plan of Uniform Accounting?" Both of these papers were actively discussed, and a number of miscellaneous topics were also brought up for discussion. A resolution was passed that in the sense of the meeting not less than ten per cent per annum is the proper depreciation charge on electrical and mechanical apparatus in private plants.

The convention held in all nearly nine hours of session, the three sittings averaging three hours each. S. H. G.

[*Special telegram to the* ELECTRICAL REVIEW]

WEDNESDAY'S PROCEEDINGS.

Cincinnati, May 21—President Doherty called the meeting to order this morning at 10.15. An unusually large attendance of members was present. A number of topical questions were considered, and then papers on "Three-Phase *versus* Two-Phase for City Distribution" were read by Messrs. B. A. Behrend and Charles F. Scott. These papers were discussed by Messrs. Peter Junkersfeld, P. A. Bertrand, R. S. Kelsch, P. G. Gossler, J. F. Dusman, Welles E. Holmes, John F. Gilchrist and Paul M. Lincoln.

Messrs. E. H. Davis, F. E. Smith and W. E. Moore were appointed a committee on memorials.

Messrs. Frederic Nicholls, James I. Ayer and H. H. Fairbanks were appointed the committee on nominations.

Topical questions were then taken up. At the afternoon session, which was called to order promptly, topical questions were further considered. Professor C. P. Matthews read the third "Progress Report of the Committee for Investigating the Photometric Values of Arc Lamps." Professor W. E. Goldsborough, on behalf of the board of directors of the World's Fair to be held in St. Louis, in 1904, extended an invitation to the association to hold its meeting in 1904 on the exposition grounds, which was unanimously accepted.

Dr. F. A. C. Perrine then read a paper on "Protection of Long-Distance Transmission Lines," which was followed by other papers on the same subject. After some discussion of the subject the meeting adjourned.

In the executive session, held Wednesday evening, the following scale of membership dues, to take effect January 1, 1903, was adopted: All new members after that date to pay an initiation fee of $25. Annual dues of members in cities of 20,000 population or under, $10; 20,000 to 300,000 population, $25; over 300,000 population, $50.

The following officers were elected for the ensuing year: President, Louis A. Ferguson, Chicago; first vice-president, Charles L. Edgar, Boston; second vice-president, E. H. Davis, Williamsport, Pa.

Executive committee: Three years—S. T. Dunham, Hartford; P. G. Gossler, Montreal; H. D. Hartman, Philadelphia. Two years—J. H. Perkins, Youngstown, Ohio; C. F. Hewitt, Elkhart, Ind. One year—Arthur Williams, New York. Secretary and treasurer, James B. Cahoon, New York. Assistant secretary and treasurer, Miss Harriet E. Billings, New York.

President Ferguson was installed and acknowledged his election in a well-worded speech.

A rising vote of thanks was tendered ex-President Doherty for his valued services rendered the association.

Papers on "Display Lighting Signs and Decorations" by Mr. Russell Spaulding, and on "Possibilities of Sign and Decorative Lighting," by E. J. McAllister, were read at the evening session.

There was a noticeable increase in the attendance to-day, many having arrived on the morning trains to remain for two days.

C. W. P.

[*Special telegram to the* ELECTRICAL REVIEW.]

THURSDAY'S PROCEEDINGS.

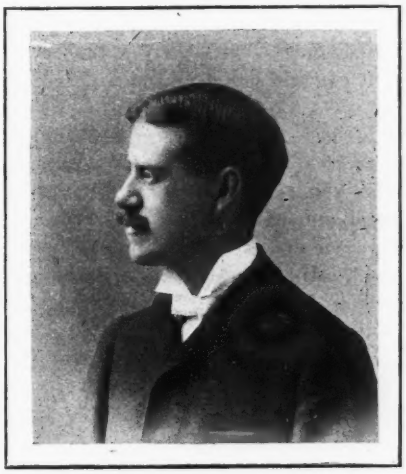
Cincinnati, May 22—Thursday was a very busy day at convention headquarters, and all of the incompleted programme was gone through with. President Doherty called the session to order promptly at ten o'clock, and at this early hour there was gathered a very large attendance, giving evidence that the interest in the work was not in any way diminishing. The first discussion was on enclosed lamps and the Nernst lamp. These questions were dealt with exhaustively, those participating in the discussion taking peculiar pains to bring out every item which might be of interest and profit in this important phase of electrical work. The questions for the day were answered at length, numerous operating companies having sent conclusive reports upon the different items submitted. Papers and topics taken up for discussion were "The Present Performance of the 220-Volt Lamp," "The Advantage of Gas Engines," "Hot Water *versus* Steam Heating," "Boiler Firing with Oil," and "What Improvement Is Desired in Meters?" These topics were very completely discussed, the papers read being of a high order of merit, the different authors having spared little effort to make their conclusions as comprehensive as possible.

The convention adjourned late this afternoon, having enjoyed an unusually well-attended and well-conducted meeting. Much of the best matter had to be omitted from these hurried despatches, but will be presented in full in the next issue of the ELECTRICAL REVIEW. About a dozen of the manufacturing companies and supply houses had headquarters and gave exhibitions of special apparatus at the Grand Hotel. These gave added interest to the many happy incidents of the convention.

The Cincinnati Gas and Electric Company has been very hospitable, and although the more northern visitors have found the weather conditions almost unbearable, it being extremely warm, every one has words of praise for this convention and the city in which it was held.

Over 300 delegates visited the extensive works of the Bullock Electric Manufacturing Company on Wednesday afternoon. President George Bullock welcomed the visitors, who were shown through every department of this thoroughly modern and well-planned electrical factory. Mr. F. G. Bolles acted as master of ceremonies, and a bountiful luncheon was served, the toasts to Mr. Bullock and Mr. Bolles being entertaining and numerous. The company is greatly enlarging its factory, a magnificent new building going up immediately adjoining the present one. The party assembled on the well-kept lawn in front of the office building and a large photograph was taken. A copy of this photograph is being sent to every one present as a souvenir of this delightful occasion. The Bullock company prepared a neat programme giving the names with a numbered button to be worn by each visitor to the city. The number on the button corresponded to the number against the visitor's name in this company's neat souvenir.

The visiting ladies have been generously entertained. Visits were made to the Rookwood Pottery and the famous Zoological Garden, where elaborate luncheons



LOUIS A. FERGUSON, PRESIDENT, NATIONAL ELECTRIC LIGHT ASSOCIATION.

were greatly enjoyed. There were in all thirteen ladies in attendance at the convention.

The executive committee has decided that the next convention of the National Electric Light Association will be held in Chicago.

C. W. P.

Electrical Equipment from a British Point of View.

[*Editorial Article in the London Electrical Engineer.*]

We always have objected, and we strongly object, to the comparisons generally made with regard to the utilization of electrical energy in this and in other countries, especially in America. The old adage says comparisons are odious, and in this case they are worse—they are misleading. At the commencement at what may be called the electrical era, say, twenty-five years ago, America had no roads—they had tracks, a few and deplorably bad at that. They had also towns and many nuclei of towns, but without any artificial light. Everything and everybody there looked upon the motto, "Go ahead," as their birthright; and go ahead it was. Plants for lighting were put down everywhere, traction schemes went ahead like wildfire, and because this was so we have been told that we were a benighted nation, never ready to take advantage of the progress of applied science, and wishful to follow in the rear instead of the front of progress. All such criticism was simply a sign of the emotional gush of the daily paper, which neither considered nor cared about different conditions, which neither considered nor troubled about practicability, but concluded without investigation that what was sauce for the newly pitched town in Texas was equally sauce for the thousand-year-old town in this country. Almost, or quite, in the early stage of electrical development we pointed out that the world would see a greater development in electrical work for power purposes than for lighting purposes—indeed, we insisted again and again that the latter might almost be looked upon as a by-product of the former. To return, however, to our immediate text—the power station of South Wales and its prospects. As we have said, an enormous horse-power is required within the area of its operations. The people who require this horse-power are already provided with it, and their question is quite different from that of one who proposes to erect a new factory or sink a new shaft. Replacing what exists is a very different matter to installing in a new concern, but England has to face this question of replacing. Assume a factory erected and equipped twenty-five years ago. Assume, further, a factory erected contiguous to the former and equipped to-day, and then ask the question, Which factory will have the pull in the competition which is to ensue between them? Assume that both are intended to produce the same class of goods. There can be only one answer to this question—that the modern factory is in a better position than the older one, and, all things equal, will be more likely to obtain a greater patronage than its older rival. The factories of America are new and newly equipped. We are told that their competition is keen, and that we are losing orders because we can not compete with them in their production. The moral of this seems to be quite clear, and it is that our own factories must be equipped with the most modern appliances and must be placed in a position of equality with those with which they have to compete.

Reviews of Current Engineering and Scientific Literature.

Giving Concisely the Substance of Important Papers in the Scientific, Electrical and Engineering Press of the World.

Processing of Copper-Nickel Sulphide Ores.

A contemporary has recently described the treatment of ores containing nickel-iron sulphides with copper-iron sulphides by subjecting comminuted ore to magnetic separation so as to produce headings and tailings, headings being richer in iron and sulphur than tailings, but generally poorer in nickel, thus bringing about by magnetic separation variation or readjustment of relative proportions of iron and nickel so as to produce proportions which are proper for making nickel and steel, then roasting headings, and finally smelting them to produce pig iron containing proportions of nickel which make it suitable for the direct manufacture of nickel alloy.—*Mining and Scientific Press*, April 26.

Composite Incandescent Lamp Filaments.

For a long time experiments have been made in many directions, looking to the combination of other materials with carbon for the betterment of incandescent lamp filaments. A number of results have been obtained which point to considerable improvement. M. F. De Mare, of Brussels, has had excellent success with filaments composed as follows: A core is prepared of magnesia, tar and carbon. Through this filament the current is passed while it is exposed to the air. The consequence is that all of the carbon is burned out, leaving a hard surface of magnesia. The next process is to flash the filament in a hydrocarbon vapor, resulting in the deposition of a layer of carbon on the outside of the magnesia. This is said to furnish an exceedingly strong filament, and one giving high efficiency. Figures have not been made public, however, regarding the candle-power per watt obtained with lamps equipped with this type of filament.—*Electrical Engineering* (London), May 2.

The Validity of Ohm's Law.

With the rapid progress of belief in the electron hypothesis of electricity the necessity arises for restating some of the older formulæ in terms of the known properties of ions, whose motions are supposed to constitute electric current. Herr J. Stark gives this equation: $J_n = n_n \epsilon v_n X$, where J_n is the current density of the negative ions, ϵ their charge, v_n their specific velocity and X the force moving them. The same author has lately shown that the limit of the validity of Ohm's law is reached when the difference between the driving forces at the beginning and at the end of the mean free path of an ion ceases to be small in comparison with the driving force itself. Whenever, on account of some sudden change of medium, there is a surface accumulation of ions producing a strong electrical field, or where in high vacua the mean free path of the electrons is of visible length, this phenomenon can occur. In the vacuum glow discharge the electrical force is very great immediately at the cathode, whereas in the negative glow it is very small. The distance between the cathode and the negative glow is smaller than the mean free path of negative ions. On this account there is a steep slope of electric force in that locality, and hence also the well-known formula of Ohm's law in the same place.—*Annalen der Physik* (Berlin), April.

Electric Power from the Victoria Falls.

The proposal to develop the power of the great falls of the Zambesi River, in South Africa, is said now to be taking definite shape, the consulting engineers of the Rhodesia railways having been retained in connection with the development. These falls are the largest in the world, being larger even than Niagara. They are about a mile wide and 420 feet high, and even in dry seasons the water is from two to three feet deep at the crest of the falls. It is proposed to erect electrical transmission lines to cover the district within a radius of 150 miles, a distance which work at California has shown to be entirely practicable. In the territory covered by this radius the Wankie coal fields and some rich copper deposits are found, as well as all the materials necessary for the manufacture of calcium carbide. The railway crosses the falls themselves and will probably be the first customer for electric power. No gold fields are found within the radius mentioned, but within a distance of 300 miles several of the larger gold-mining centres are included. It is hoped that some day, with improved methods of transmission, power will be available for delivery in the Rand district, near Johannesburg, 600 miles distant. The enormous industrial resources of this region would doubtless furnish an admirable market for all the power that might be developed.—*Electrical Engineering* (London), May 2.

Platinum in Australia.

While it has been known for some time that platinum is found in various places in Australia, the output up to now has been comparatively small. In 1900 the output was 530 ounces, valued at $5,035, while the total quantity brought out since the beginning of 1894 is 8,295 ounces, valued at about $61,000. The chief difficulty met in prospecting for the metal in Australia has been the scarcity of water in districts where it is found, so that mining operations on an extensive scale are not practicable. Platinum is always found in the metallic condition, generally more or less alloyed with iridium, osmium, palladium or other rare metals, or else in the mineral sperrylite, which is an arsenide. In the Fifield district, about 320 miles west of Sidney, which is the principal place in which platinum is found in New South Wales, it is discovered associated with gold. In the small township of Platina there is an alluvial lead over a mile in length, and varying from 60 to 150 feet in width, containing platinum and gold. These metals occur in coarse, water-worn grains, and are generally confined to cavities in the bed-rock. The largest nugget of platinum yet found weighs twenty-seven pennyweights. The wash-dirt contains from five to twelve pennyweights of platinum and from one to three pennyweights of gold per ton. Platinum is also found in the Broken Hill district and in many other localities, including the beaches of the northern coast, where it is found in the gold-bearing sands.—*Electrical Engineering* (London), May 2.

Hertz Waves in Thunder-Storms.

In a note to the French Academy, M. F. Larroque has already shown that lightning flashes emit electrical waves capable of being propagated to enormous distances. He received the waves upon a short vertical wire connected with the earth, and furnished at its upper end with a horizontal metallic plate. In this wire is a narrow spark-gap wherein sparks may be observed by a microscope. The author has now noted that the removal of the horizontal plate renders the system inert, but that the elimination of the vertical portion has no apparent influence upon the sensitiveness of the apparatus. From this he concludes that the electric oscillations are horizontal. In the case, however, of very distant storms, those, say, about 300 kilometres away, he has discovered that the electrical vibrations are vertical.—*Comptes Rendus* (Paris), March 24.

Auto-Decoherers.

In a note presented to the French Academy, M. O. Rochefort discusses at length the question of self-decohering coherers. It has been stated that the difficulty of regulating auto-coherers is due to the fact that the limits between the imperfect contact, not quite at the cohering stage, and the imperfect contact which will cohere but requires tapping, are too close to allow a self-righting coherer to be made with imperfect contacts. M. Rochefort shows that every self-righting coherer may be transformed into one of the ordinary kind by diminishing the pressure on the filings. He is not yet prepared to state whether the converse also holds true. Great practical improvement is believed to attach to coherers which automatically decohere. By slight modifications of the soft iron coherer the author has succeeded in using it for wireless telephony. These coherers may be regulated by an external magnetic field with great advantage and certainty.—*Comptes Rendus* (Paris), April 14.

Preparation of Radio-Active Surfaces.

An interesting detailed description is given by Herren Elster and Geitel, of a method of preparing radio-active surfaces by exposure to the air. The apparatus is very simple, including only the ordinary induction coil of commerce and the stretched wire which is to be made radio-active. The best form of conductor to be put into the radio-active state is a thin wire, since the electrical density on its surface is comparatively high even at low potentials. Such a wire is stretched and maintained at a negative potential of a few thousand volts, and is then able to exhibit radio-active effects. The active surface of the wire may, as Professor Rutherford has shown, be rubbed off on a leather pad and so obtained in concentrated form for photographic purposes. Either copper or aluminum is satisfactory material for the purpose. The active surface of copper may be rubbed off with the aid of ammonia, while that of aluminum may be removed by simple friction. The wire should be about 0.5 millimetre in diameter and not shorter than ten metres. The charged wire should be very carefully insulated, as the induced activity increases with the potential to which it is charged. The authors state that they have succeeded in preparing active surfaces on leather in this manner equal to uranium ore.—*Physikalische Zeitschrift* (Berlin), April 15.

The Simplon Tunnel.

Some very interesting engineering methods are being employed in drilling the great railway tunnel under the Simplon Pass between Italy and Switzerland. Mr. S. Pestallossi describes some of these as follows: The drills used in working the rock are of the rotary type, and are worked by water pressure of from 1,000 to 1,400 pounds per square inch. This water is led through pipes about four inches in diameter up to a point about forty yards from the working face, whence the water proceeds through three-quarter-inch or two-inch flexible pipes to the drilling machines. The holes drilled are two and three-quarter inches in diameter, from six to twelve being drilled for each blast. When the drilling is completed, the flexible connecting pipes bringing in the water are removed and the drill is run back along its track to a safe distance from the face. About eighty-eight pounds of dynamite are fired at a blast. Experiments with liquid air as an explosive agent were not satisfactory. Very elaborate provisions are made for ventilating the workings and blowing out the gases resulting from the explosions of dynamite. The advance heading is driven at the floor level of the tunnel, and is from eight to ten feet wide and from six to eight feet high. This heading is enlarged as the work goes on to the full tunnel section. Work has progressed at the rate of nearly five feet per blast, or twenty-five feet per day, from both ends of the tunnel until a recent outbreak of water checked progress on the south side. This tunnel, which will be the longest railway tunnel in the world when completed, will be operated by electric traction exclusively, power being derived from waterfalls in the vicinity of the two ends.—*Schweizerische Bauzeitung* (Zurich), April.

The Berlin-Zossen High-Speed Traction Experiments.

Only a few of the results obtained in the traction experiments on the military railroad near Berlin have yet been made public. The following is the first statement that has been made regarding the tests: At high speeds great trouble was had with the tracks. The rails weighed only sixty-seven and one-half pounds per yard and were spiked, for the most part, to wooden cross-ties, although a few iron ties were also used. As long as the speed did not exceed 100 kilometres per hour no evil effects were noticed, but when the speed went to 140 kilometres (87 miles) per hour the carriage began to roll a little, owing to the lightness of the permanent way. The experiments show that eighty-five-pound rails would be heavy enough for speeds up to 100 miles an hour. The three-axle trucks upon which the cars were mounted ran very quietly and gave great satisfaction. There was very little sparking at the contact devices in spite of the high speed of 130 feet per second. It is believed that the solution of the problem of feeding current to the car was solved with entire success. During the experimental runs the cars traveled about 1,860 miles. The tests were finally stopped on account of the yielding of the track, both horizontally and vertically. It was decided that at the high speeds contemplated brake discs should be put on the axles and that the brakes should not act directly upon the wheels for fear of slipping the tires. The hand-brakes managed to stop the car in about 2,350 feet. At the speed of 96.5 miles per hour, the car was stopped by the air-brakes in 67 seconds, having run one mile. At the speed of 68.5 miles, the car was stopped in 32 seconds, having run 0.34 mile. Cutting off the current at a speed of about 67 miles an hour and allowing the car to drift on the level track it came to rest in 817 seconds, after running 5.95 miles. Power consumption at various speeds was as follows: 56 miles an hour, 184 kilowatts; 87 miles an hour, 520 kilowatts; 120 miles an hour, 825 kilowatts. The overall efficiency of the whole plant, from the engines at the generating station to the rims of the car-wheels, was 45 per cent. Signals could not be distinguished easily at a speed exceeding 75 miles an hour, and rain striking the windows at this speed interfered greatly with the visibility of the signals. The latter will have to be made very large and clear and placed a mile or more in advance of their destination. Heavier rails are to be put down and the road-bed improved to permit the equipments to attain the full speed for which they were designed.—*Engineering* (London), April 25.

Convention Notes

The majority of manufacturers did not make exhibits at this convention, but were in personal attendance upon the meetings or else were represented by gentlemen from their sales organizations. Some specimens of new apparatus were shown, but not so much as usual at former conventions.

The Grand Hotel was beautifully and elaborately illuminated by means of 6,000 lamps installed on the "Elblight" system. This method of decoration with electric lights has lately become very popular. The lamps are arranged to be attached to a wire or to boards, and to light wherever placed. This system is being introduced throughout the country by the National Electric Improvement Company, of New York.

Mr. Guy McGest, who has a contract for lighting the new electric underground conduits for the Cincinnati Gas and Electric Company, entertained a large number of delegates and visitors in a big manhole at Central avenue and Charles street. The interior of the manhole had been elaborately decorated and prepared for the occasion. Refreshments were served and a musical programme was given during the various days of the convention session.

In the last two years the membership of the association has practically doubled.

President Doherty was one of the hardest working officials who has ever occupied the presidency of the association. The seventeen fine papers presented at this meeting show how great has been his energy and application.

The entertainment committee did its work of arranging hotels, entertainments, etc., to the very great satisfaction of everybody.

The special Baltimore & Ohio train from New York came to grief through one of its cars being partially wrecked in coupling the train together. The party were delayed several hours. Among those on this train were: C. J. Harrington, C. B. Myers, Robert W. Wyant, Frank Harrington, W. S. Rugg, Calvert Townley, W. A. McClurg, W. E. Holmes, George K. Boutelle, W. S. Barstow, Ralph Pattison, C. E. Bibber, Frank O. Barnes, Orrin Smith, W. J. Jones, J. D. Israel, A. J. DeCamp and Mrs. DeCamp, Alexander Henderson, W. S. Eckert, F. P. Lupke, J. Jones, Jr., George B. Davis, F. Flanigan, Professor L. B. Marks, M. L. Godkin, S. L. Pancoast, E. H. Farr, E. P. Powell, W. F. Hunt, D. F. Irvins, Robert T. E. Lozier and Harry Alexander. The parties that left New York and Philadelphia Sunday by the Pennsylvania Railroad arrived on time and traveled very comfortably.

A large party came from New York and points in New England, reaching Cincinnati Monday, by way of the New York Central & Hudson River Railroad and the "Big Four" route.

Mr. Charles G. Wertz, of Cincinnati, was the representative of the Elliott & Hatch Book Typewriter Company.

The Standard Paint Company, manufacturer of P & B and other well-known insulating and electrical compounds, was represented by Mr. H. W. Benedict, of New York, and Mr. J. E. Shainwald, of Chicago.

The Banner Electric Company, of Youngstown, Ohio, was represented by Messrs. L. N. Norris, F. C. Kirchmer, John E. Hart and R. T. Hamilton, all of Youngstown.

Mr. Edmund Dickey, of Lancaster, Ohio, was present in the interests of the Consumers Carbon Company.

Mr. F. W. Willcox, of Harrison, N. J., was the representative of the General Electric Company's Edison lamp works, and the author of an interesting paper in the symposium on lamp efficiency.

The Helios-Upton Company was represented by Mr. Charles D. Meyers, of Philadelphia, Mr. King Upton, of Boston, and Mr. Robert C. Gregg, of Chicago.

Mr. F. W. Hawkins, of New York, Mr. John W. Brooks, of Chicago, and Mr. C. M. Crofoot, of Cincinnati, were the representatives of Pass & Seymour.

Mr. David C. Jones and Mr. Sam Meyer were the representatives of the Lunkenheimer Company, of Cincinnati, manufacturer of steam fittings.

The Bullock Electric Manufacturing Company was well represented during the days of the convention, many of its engineers, officers and sales department force being present. Among them may be mentioned: Mr. George Bullock, president of the company; Mr. B. A. Behrend; Mr. L. B. Hoyt; Mr. F. G. Bolles; Mr. Alfred Collyer, of Montreal; Mr. S. J. Hendy, of San Francisco; Mr. J. A. Summers, of Knoxville, Tenn.; Mr. G. P. Thurber, of Pittsburg; Messrs. M. F. Quill, George M. Gest and W. R. Harris, of Cincinnati, Ohio; Mr. Robert Lozier, of New York.

Mr. W. H. Jacob, of Cincinnati, was present in the interests of the Triumph Electric Company.

Mr. J. Allen Heany, of Philadelphia, inventor of a well-known type of arc lamp, was present to represent his company, the American Electric Manufacturing Company, of Philadelphia.

The Shedd Electric and Manufacturing Company, of New York, maker of oscillating electric fans, was represented by Mr. Theodore A. Moolten.

Mr. John A. Stewart, of the Stewart Electric Company, Cincinnati, was present at most of the meetings.

The Gould Storage Battery Company was represented by Messrs. William W. Donaldson and A. S. Hubbard, both of New York, and also by Messrs. Charles M. Gould and F. P. Huntley.

Mr. Charles A. Sanders, of Boston, was the representative present of the Marshall-Sanders Company, of that city.

Mr. C. J. Letscher, of the Illinois Electric Company, of Chicago, was in attendance at the convention.

The Elkhart Electric Company, of Elkhart, Ind., was represented by Mr. C. F. Hewitt.

Mr. Lewis F. Kaiser was the representative present of Thomas Emery's Sons.

The General Incandescent Arc Light Company, of New York, was represented by Messrs. Martin J. Insull, F. C. Colwell and J. Henry Hallberg.

Mr. P. F. Lyons, of Bristol, R. I., was present as the representative of the National India Rubber Company.

Mr. W. J. Phelps, of Detroit, the inventor of the well-known "Hylo" lamp, was present in the interests of his company.

Messrs. W. P. Bowman, of Cleveland, Ohio, George C. Bailey, of Chicago, F. W. Harrington, of New York, and D. F. Ivins, of Trenton, N. J., were among the representatives of the John A. Roebling's Sons Company.

Mr. John Dale, of New York, was present, with Mr. O. J. Bryan, in the interests of the Dale Company, which manufactures electrical specialties of many kinds.

The Western Electric Company was represented by Mr. Robert Edwards, Jr., of its New York branch; also by E. W. Rockefellow, of New York, and J. J. Kessler, of St. Louis.

The Phœnix Glass Company, of New York, the well-known maker of globes and shades for electric lights, was represented by Mr. E. H. Peck.

The Chase-Shawmut Company, of Boston, was represented by Mr. H. P. Moore.

The Pettingell-Andrews Company, of Boston, dealers in electrical supplies, were represented by W. J. Keenon.

Mr. J. A. Vaughn, of New York, was the representative of J. B. Buchanan & Company, of Philadelphia.

The Electric Motor and Equipment Company was represented by E. J. McHillertes.

The New York & Ohio Company, maker of electrical specialties, was represented by Mr. W. D. Packard, of Warren, Ohio.

Messrs. Rossiter, MacGovern & Company, of New York, dealers in electrical and other machinery, were represented by Mr. J. A. Peirce, of St. Louis.

The Buckeye Electric Company and the Jandus Electric Company were represented by Mr. E. H. Nash, of Philadelphia, and J. H. Cooke, of Chicago.

The American Electrical Works, of Phillipsdale, R. I., was represented by Mr. F. E. Donohue, of Chicago.

The Columbia Incandescent Lamp Company, of St. Louis, sent as its representatives Mr. George E. Watts and Mr. W. O. Garrison.

The Sterling Electric Manufacturing Company, of Cleveland, was represented by Mr. T. B. Pritchard and Mr. William Coale.

Mr. T. S. Watson, of Milwaukee, represented the Mechanical Appliance Company.

Mr. D. A. Schutt was present from Peru, Ind., as representative of the Peru Electric Manufacturing Company.

The Robbins & Myers Company, of Springfield, Ohio, was well represented by Messrs. Mumma, Conklin and Thompson.

Mr. W. S. Nourse, of Cincinnati, was the representative of the Lane & Bodley Company, manufacturer of engines.

Dr. Frederick A. C. Perrine, of Pittsfield, Mass., Mr. R. D. Lillibridge, of New York, and Mr. V. W. Bergenthal, of Chicago, were present in the interest of the Stanley Electric Company.

The National Carbon Company was represented by Messrs. A. D. Spear, of Cleveland, Ohio; F. H. Murray, of Cleveland, Ohio; F. H. McDowell, of Pittsburg, Pa.; A. E. Carrier, of New York, and F. C. Park, of Boston, Mass.

The Creaghead Engineering Company, of Cincinnati, had present as its representatives Messrs. Thomas L. and J. H. Creaghead.

Mr. H. J. Tremaine, of Fostoria, Ill., represented the Crouse-Tremaine Carbon Company.

Mr. T. A. Moloney, of St. Louis, president of the Moloney Electric Company, manufacturer of transformers, was present at the convention.

The Hart & Hegeman Manufacturing Company, of Hartford, was represented by Mr. G. S. Searing, of Chicago, and Mr. R. B. Corey, of New York.

The Fostoria Incandescent Lamp Company was represented by Messrs. Robert Crouse and B. G. Tremaine, of Cleveland.

Mr. J. B. Crankshaw and Mr. William McCullum, of Cincinnati, looked after the interests of the Electric Railway Equipment Company.

Mr. John S. Nowotny, of the Nowotny Electric Company, was present at the various sessions of the convention.

The Jantz & Leist Company, of Cincinnati, was represented by Mr. Carl T. Schloctermeyer.

The National Conduit and Cable Company, of New York, maker of insulated wires and cables, was represented by Mr. W. S. Eckert, of New York, and Mr. H. F. Tate, of its Chicago office.

The Warren Electric and Specialty Company, maker of a wide variety of electrical specialties, was represented by Elmer W. Gillmer, of Warren, Ohio.

The Pittsburg Armature Company sent Mr. F. W. Kossler as its representative.

The Pittsburg Electric Lamp Company had its interests in the hands of Mr. E. R. Morrow.

Among the large number of gentlemen representing the Westinghouse Electric and Manufacturing Company were: W. R. Pinckard, Chicago, Ill.; C. S. Powell, Cleveland, Ohio; Arthur Hartwell, Pittsburg, Pa.; Frederick H. Taylor, Pittsburg, Pa.; D. D. Pendleton, Pittsburg, Pa.; W. H. Whiteside, Pittsburg, Pa.; Alfred Goodby, Pittsburg, Pa.; Henry D. Shute, Pittsburg, Pa.; G. Brewer Griffin, Boston, Mass.; Percy R. Frost, Pittsburg, Pa.; R. U. C. Barnes, of Boston; Paul T. Brady, Syracuse, N. Y.; George W. Pulver, Syracuse, N. Y.; H. P. Davis, Pittsburg, Pa., and P. M. Lincoln, Pittsburg, Pa.

The General Electric Company was admirably represented by J. R. Lovejoy, the manager of the lighting department; A. D. Page, manager of the incandescent lamp sales; J. B. Pevear, manager of the Cincinnati office; C. B. Davis, manager of the Boston office; Irving Hall, manager of the Denver office; and A. L. Rohrer, E. E. Gilbert, P. D. Waggoner, H. W. Hillman and H. Vaughen, of Schenectady, and F. B. Fox, of Lynn, and others.

The Fort Wayne Electric Works exhibited arc lamps of every description, its "Type K" meters, motor-starting panels and a splendid line of miscellaneous instruments: the revolving fan motor was a prominent feature of the exhibit, many fans being distributed throughout the hotel. This company was represented by F. S. Hunting, general sales manager; A. A. Serva, assistant sales manager; F. L. Sturgeon, Indiana representative; T. J. Ryan, Cincinnati office; J. E. Hall, Pittsburg office; W. S. Goll, Chicago office; W. C. Knight, Chicago office.

The Buckeye Electric Company, manufacturer of the Buckeye electric lamp, was represented by Mr. T. W. Bliss, and Mr. Charles J. Wells, of Cleveland, Ohio, and Mr. F. J. Stafford, of Pittsburg, Pa.

The United States Carbon Company was represented by Mr. B. P. Foster, Cleveland, Ohio.

The American Circular Loom Company was represented by Mr. H. B. Kirkland and Mr. Thomas G. Grier, Chicago, Ill.

Mr. Oscar Carman, of Indianapolis, Ind., was the representative of R. L. McOuat.

Mr. C. G. Luthy, Peoria, Ill., represented the Royal Electric Company.

The Bryan-Marsh Company, manufacturer of electric lamps, was represented by Messrs. Converse D. Marsh, of New York, president of the company, and Guy V. Williams, of Minneapolis, Minn.; J. C. Keech, Chicago, Ill.; E. H. Horton, Chicago, Ill., and W. H. Roberts, of New York, N. Y.

Mr. G. Brewer Griffin, Boston, Mass., represented the Manhattan General Construction Company.

Mr. C. H. Hill, Pittsburg, Pa., was present at the convention.

The Nernst Lamp Company was represented by Mr. Calvin W. Rice, Pittsburg, Pa.; Mr. A. E. Fleming and Mr. A. J. Wurts, Pittsburg, Pa.

The Standard Underground Cable Company was represented by Messrs. T. E. Hughes, of Philadelphia, Pa.; J. R. Wiley, Chicago, Ill., and C. J. Marsh.

The Colonial Electric Company was represented by Mr. J. B. Estabrook, Ravenna, Ohio.

Mr. Elmer W. Gillmer and Mr. E. E. Nash, Warren, Ohio, represented the Warren Electric Specialty Company.

The Western Electric Company was represented by Oscar C. Turner, Chicago, Ill.; L. Gutmann, Peoria, Ill., and C. W. Cobb, Cleveland, Ohio.

The American District Steam Company, Lockport, N. Y., was represented by Mr. H. C. Eddy, Chicago, Ill.

Mr. G. H. T. Lane and W. S. Nourse, of Cincinnati, Ohio, were the representatives of the Lane & Bodley Company.

The McRoy Clay Works was represented by Mr. E. F. Kirkpatrick, of Chicago, Ill.

Mr. George Cutter, of Chicago, Ill., was a prominent figure at the convention.

The Safety Insulated Wire and Cable Company was represented by Mr. E. J. Spencer, of St. Louis, Mo.

The Sterling Electrical Manufacturing Company was represented by Mr. J. N. McNair, of Warren, Ohio.

The Electric Storage Battery Company was represented by Mr. Charles Blizard, Philadelphia, Pa., and Mr. E. Vail Stebbens, Cleveland, Ohio.

The Kuhlman Electric Company was represented by Mr. E. Kuhlman, of Elkhart, Ind.

The Sunbeam Incandescent Lamp Company was represented by its vice-president, Mr. F. S. Terry, of New York.

The Hill Clutch Company was represented by Mr. H. W. Hill, Cleveland, Ohio.

Mr. Frank A. Wolff, Jr., of Washington, D. C., was the representative of the National Bureau of Standards.

S. B. Condit, Jr. & Company, was represented by Mr. S. B. Condit, Jr., of Boston, Mass.

The Sawyer-Man Electric Company was represented by Messrs. T. H. Bailey Whipple, New York, N. Y.; Clarence A. Ross, of Chicago, Ill.; and George A. Nellis, Pittsburg, Pa.

The Upson-Walton Company was represented by Mr. F. C. Anderson, Cleveland, Ohio.

Mr. Robert W. Francis, of Chicago, Ill., and Mr. Dan Delaney, of Cincinnati, represented the Dearborn Drug and Chemical Company.

The Holophane Glass Company was represented by Mr. M. G. Davies.

The Central Electric Company was represented by Mr. Adam S. Pearl, Chicago, Ill.

Mr. G. H. Sheefer, Peoria, Ill., represented the Diamond Meter Company.

The Stirling Boiler Company was represented by Mr. W. S. Elliott and Mr. E. K. Gillette.

G. S. Ellis & Son were represented by Mr. William Cherrey Ellis, Cincinnati, Ohio.

Professor W. E. Goldsborough, of Purdue University, was the representative of the Department of Electricity of the World's Fair, St. Louis.

The Illinois Electric Vehicle Transportation Company was represented by Mr. T. R. Jenkins, Chicago, Ill.

Mr. E. L. Willson, Ashland, Ky., represented the Triple State Company.

The New York Insulated Wire Company was represented by Mr. James Wolff, Chicago, Ill.

The Osburn Flexible Conduit Company was represented by Mr. C. E. Corrigan, of New York, and Mr. J. S. Monroe, of Cincinnati.

Mr. J. Ryan, of Cincinnati, and Mr. A. A. Serode, of Fort Wayne, looked after the interests of the Fort Wayne Electric Works.

The Post-Glover Electric Company, of Cincinnati, was well represented by Messrs. Samuel Glover, F. D. Van Winkle, George Devou and C. S. Kuntz.

Mr. E. W. Estep, of Cincinnati, was the representative of the I. & E. Greenwald Company.

The Aultman & Taylor Company, builder of steam boilers, was represented by Mr. A. H. Lewis.

Mr. V. T. Price, of Cincinnati, looked after the interests of the Buckeye Engine Company.

The Devere Electric Company, of Cincinnati, was represented by Mr. John Devere.

Mr. A. C. Beattie, of Cincinnati, was the representative of the Beattie Electric Company.

Mr. W. A. Hall, of Cincinnati, Mr. George H. Jones and Mr. William Albert Hall cared for the interests of the Hubbard Hall Company.

Mr. Robert B. Corey, of New York, was present in the interests of the Hart & Hegeman Manufacturing Company, of Hartford, Ct., and the American Circular Loom Company.

The Manhattan Electrical Supply Company, of New York, maker of a large variety of electrical supplies, was represented by Mr. T. W. McDowell.

Mr. C. J. Harrington, of New York, was present in the interest of the Scranton Fire Brick Conduit Company.

Mr. J. S. Hinds, of Syracuse, N. Y., and Mr. C. N. Crofoot, of Cincinnati, were present in the interests of the Crouse-Hinds Electric Company, of Syracuse.

The American Vitrified Conduit Company was represented by Mr. B. S. Barnard, of New York.

The Stanley Instrument Company, of Great Barrington, Mass., was represented by Mr. F. J. Alderson, of New York.

The Standard Chemical Company was represented by Mr. George B. Davis, of Boston.

The National Electric Improvement Company, of New York, maker of the "Elblight" system, was represented by Mr. Russell Spaulding, its general manager.

Mr. J. C. Schaeffer, of New York, was the representative of the National Electric and Manufacturing Company.

The Adams-Bagnall Electric Company was represented by Mr. J. G. Pomery, of Chicago.

Mr. C. F. Munder, of the Munder Electric Company, Springfield, Mass., was in attendance upon the convention.

Mr. James Jones, Jr., of New York, represented J. Jones & Son, makers of electrical specialties.

Mr. George T. Manson, of the Okonite Company, was one of those in attendance upon the convention.

Mr. E. B. Baker, of New York, was in attendance as a representative of the Gray Telephone Pay Station.

The Wagner Electric Company, of St. Louis, was represented by Mr. C. C. Badeau.

Mr. W. S. Monroe, of the Monroe Brass and Wire Company, of Cincinnati, was an attendant upon the convention.

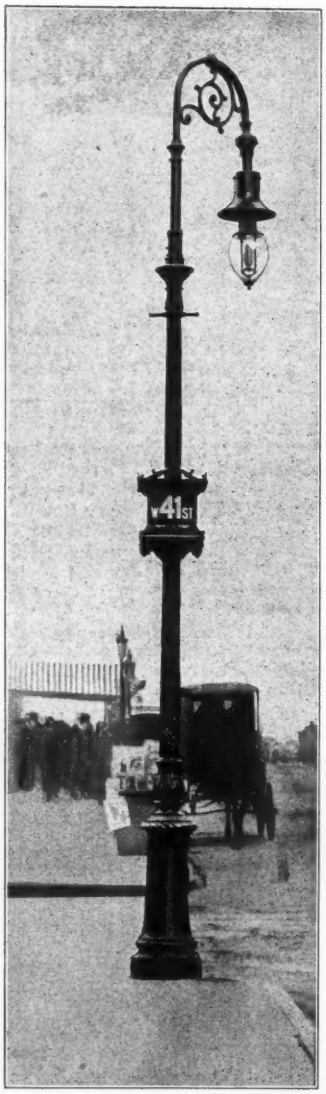
Mr. C. N. Crofoot, of Cincinnati, acted as representative of the Pass & Seymour Manufacturing Company.

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

The New Standard City Lamp-Post.

The accompanying illustration, which has been reprinted from the *Bulletin* of the New York Edison Company, shows a standard Edison lamp-post equipped with one of the company's new signs. At night the sign is illuminated by incandescent lamps placed inside and forming part of the resistance in series with the arc lamp

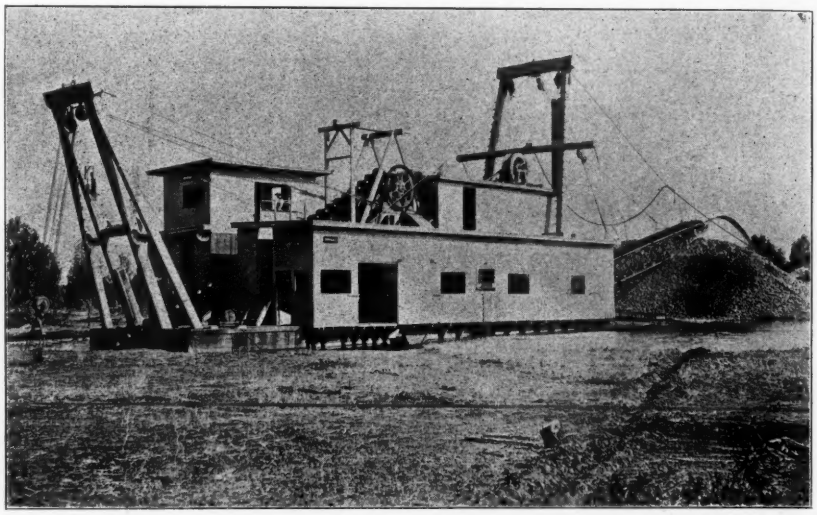


THE NEW STANDARD CITY LAMP.

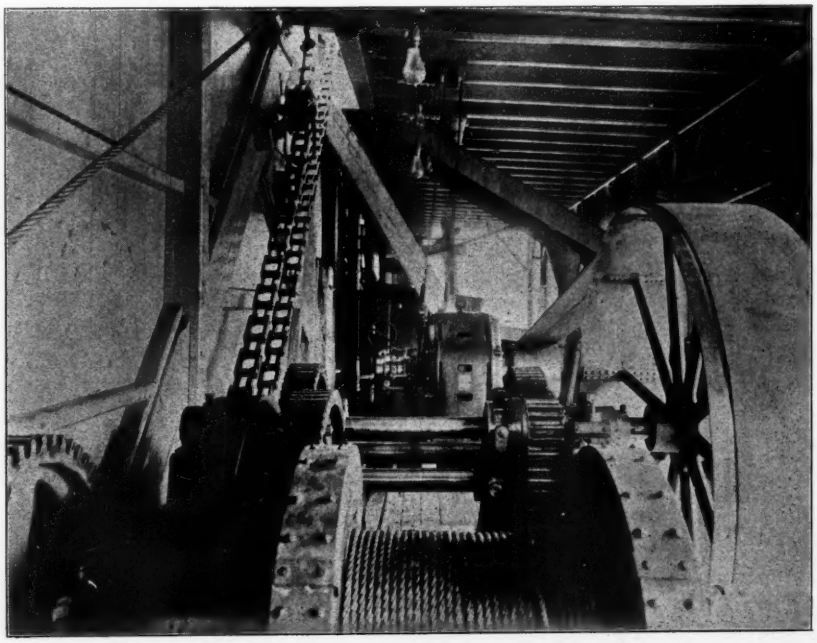
on the post. The arc lamps and posts were especially designed and represent the latest development in street lighting. Each post is independently controlled and is directly supplied with current from the Edison street lamps. The New York Edison Company supplies a total of over 3,000 city arc lamps of which more than 500 are of the type illustrated.

Electrically Operated Gold Dredge.

Gold dredges operated by electric motors are doing much to reclaim the enormous wealth of gold lost by the wasteful methods of early placer mining. The Bucyrus Gold Dredging Company has recently purchased from the Westinghouse Electric and Manufacturing Company, of Pittsburg, Pa., a large amount of electrical machinery for the operation of its dredges in California. The chief point of activity in California at the present time is on the Feather River, at Oroville. In early mining days in California the Feather River was the scene of great activity in placer mining, many million dollars worth of gold being taken out of Feather River Cañon. A great deal of this gold, owing to primitive methods of handling, was not saved and was deposited with the "slickens" on the flats at the mouth of the cañon, below Oroville. An area of about 10,000 acres is now being partially worked over by gold dredges. Hydraulic mining having been prohibited and the bed-rock being found at a great depth, the



AN ELECTRICALLY OPERATED GOLD DREDGER.



INDUCTION MOTOR OPERATING GOLD DREDGER.

only feasible method of lifting this gold-bearing gravel from the bed of the river or old channels is by the dredging process of mining. The profits of operation have frequently been $1,000 per dredge daily.

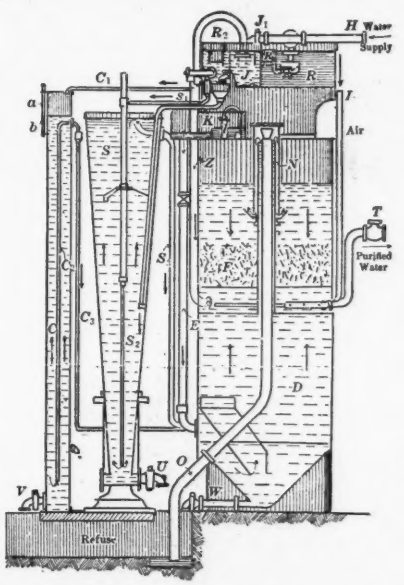
Each dredger costs from $40,000 to $75,000, depending on its capacity. The operation of the dredge is accomplished entirely by electric motors, the current for which is obtained from long-distance transmission companies operating in this neighborhood. Transformers are usually placed upon the bank to lower the voltage of long-distance lines, and flexible cables run from the bank to the top of the dredge, and from there to the various motors. There are usually installed motors of an aggregate capacity of 75 horse-power to 200 horse-power on each dredge. One of the accompanying photographs shows a variable speed induction motor driving a counter-shaft, from which the main dredging buckets are operated. These buckets raise the material from the bed of the river to the shaking screens on the top of the dredge.

An Automatic Feed-Water Purifier.

The steam generating plant is one of the most important features of a street railway power station, and the designer concentrates much thought and bestows a great amount of effort upon the best methods of arranging batteries of boilers with relation to the position of the engines, and the most economy in efficient distribution of the steam mains, headers, valves, etc. Close attention has been paid by students of engineering to these details, and everything has been done along this line with the object of minimizing the cost of producing mechanical power from the combustible used. All modern boilers bring either a large number of pipes containing water in closer proximity to the grate or else pass the burning gases through pipes surrounded by water, in this way transmitting directly the heat through the tube to the water. Any change in the conductivity of heat by the sides of the pipes, therefore, very materially interferes with the steam-generating properties of the boiler.

It is an unfortunate circumstance that but few localities have a water supply which, in its natural state, can be heated to the boiling point without the deposition of some foreign matter contained in its solution or a sediment upon the vessel containing it, and in the case of the boiler this matter forms what is widely known as scale, on either the interior or exterior of the tube, as the case may be. It is very evident that this scale, thus formed, will decrease to a very great extent the heating effect of the fire and much has been said and written upon the ratio of decrease which takes place under these conditions.

Inventors and manufacturers have produced, from time to time, many devices which had for their origin the properties of either ridding the boiler of scale which may have already formed or of so softening and purifying the water as to render the formation of scale within or without the tube almost impossible. In the accompanying illustration is shown an apparatus that is intended automatically to purify all kinds of feed water. It is claimed by the makers that no matter what the condition of the water when taken in at the supply pipe, and whether the impurities consist of suspended particles or of foreign matter held in solution, the water which issues



Automatic Feed-Water Purifier.

from the apparatus will be in perfect condition for the boilers. The only attention required by the device is the filling of the storage receptacles once a day with the necessary proportions of lime and soda, the only chemicals used in the system, the process being entirely automatic. The purifier consists essentially of an automatically acting lime saturator, showing at the left as a conical pipe; a soda chamber which is a cylindrical pipe-like receptacle, and an automatic filter in the main part of the apparatus. The lime saturator, on account of its downward tapering shape, thoroughly mixes the lime with the incoming water, the water being carried to the base of the cone by the internal pipe and slowly rising to the top through the more densely saturated solution at the bottom. The lime water is perfectly clarified by the time it gets to the wide space at the top, and leaves the saturator through a pipe which carries it to the bottom of the large cylinder. This portion of the apparatus is known as the reaction chamber and a concentrated solution from the soda chamber is forced into it through a small pipe. The difference in the methods by which the soda and the lime are dissolved is necessitated by the fact that while lime will only dissolve in a definite proportion, there is practically no limit to the solubility of soda. The soda solution is forced out of the soda chamber by allowing water to flow in through a small regulating valve, the specific gravity of the air above the soda solution being too small to cause a mixture of the two liquids.

In order to obtain the correct proportions of the mixing in the reaction chamber the apparatus in detail has been ingeniously worked out. A flood valve in the distributing tank at the top keeps the water always at the same level, and the arm is connected to other small valves at an equal height, the first one allowing the inflow of the untreated water, the second the lime water and the third the water which is used to force the soda solution into the reaction chamber. The lime is slacked in the chamber containing the distributing tank, and the lime paste resulting is carried to the interior of the conical lime saturator to a point about half way from the top. The other liquids remain in the reaction chamber at the lower part of the large cylinder until the chemical reaction of the salts has been completed, and the purified water then passes through a filter to be discharged at the relief valve perfectly softened and clarified. The sediment that results from the chemical action in the reaction chamber is precipitated to the bottom of this chamber and can be readily drawn off. An automatic washing apparatus, which is provided for the filter, prevents any choking up at this point. The Automatic Water Purifying Company, of New York city, controls the rights of this apparatus for the United States.

A Summer School for Apprentices and Artisans.

The College of Engineering of the University of Wisconsin will begin its second summer session of its summer school for apprentices and artisans on June 30, 1902. The session lasts until August 8, 1902. This school is intended primarily to give to students, engineers, superintendents of power stations, machinists, artisans and apprentices in various trades such mathematical, laboratory and shop instruction as would be found of most practical value to persons in these employments and which could be imparted in the limited time of six weeks.

A New Enclosed Series Arc Lamp.

A recent type of long-burning series differential enclosed arc lamp has been introduced to a considerable extent among central station operators by the Fort Wayne Electric Works. The new lamp has many features of construction which appeal particularly to those who have the care and operation of arc lamps. The general appearance of the lamp is shown in the accompanying illustration, but there are several features which are not apparent in the illustration. The cap and top of the case from which the lamp is suspended and which support the mechanism of the lamp are of cast iron and prevent any distortion of the parts in case the lamp should be roughly handled. The cylindrical part of the case is made of heavy copper sheeting with one soldered lapped joint. It is held in place by a bayonet catch, and is weather-proof and designed to withstand extraordinary usage. The mechanism is of the differential type and is extremely simple in construction. When the lamp is in operation the armature is practically in a horizontal position, directly beneath the series and shunt magnets. This makes a magnetic floating suspension for the armature and reduces friction to a minimum.

The series shunt coils are wound on independent cores and held in place by one large screw which can be easily removed with an ordinary screw-driver. These coils are so proportioned that they have considerable radiating surface per watt of energy expended in them and operate at low temperature. All connections that carry current are made with proper clips and fastened by two screws. These screws enter into cast-brass lugs, which are mounted in a position where they are readily accessible. The loosening of one of these screws breaks five connections, and the loosening of the other breaks three connections.

The adjustment coil, by means of which the voltage at the arc is regulated on circuits of different voltage, is wound on a form consisting of a brass tube covered with asbestos and mounted on a cylindrical wood core. This rigid construction prevents the wire from becoming loose and allows the coil to be readily removed from the lamp by loosening the clip screw at the top and bottom of the core.

The cutout is unique in design and is so constructed that it can not get out of order. It is composed of three stationary parts and one moving part. A brass cylinder traveling in a vertical direction makes and breaks contact with the stationary terminals in such a manner as to bring the arc always on the same contact. The various parts of the cutout can be readily removed in a few seconds.

In the outer globe-holder provision has been made for the expansion of the globe when heated by the arc. The globe is clamped in place in the holder by thumb-screw clips with specially designed springs that fit the curvature of the globe and will not permit the clamping screw to exert sufficient pressure to crack the globe. The globe-holder is held in position directly beneath the radiator by a bayonet catch similar to that holding the cylindrical case and has attached to it a chain from which it is suspended while the lamp is being trimmed. The assembled globe-holder may be removed entirely by simply lifting the chain and hook from a lug cast on the side of the radiator.

NEW ENCLOSED SERIES ARC LAMP.

The lamp is equipped with a corrugated cast-iron radiator which rapidly dissipates the heat which rises from the arc and prevents its entrance to the mechanism chamber, and ensures extremely low operating temperature in the lamp. The radiator is designed to permanently protect all parts of the lamp located beneath it from moisture, snow and dirt, and all parts located above it from the heat of the arc.

The clutch is what is known as the three-jaw ring clutch and is extremely simple in construction. On the top and in the centre of the main-clutch casting is mounted a small copper ring with three inwardly projecting jaws. Only these three jaws come in contact with the carbons. This arrangement allows the use of carbons differing slightly from the standard size specified to be used with the lamp. The small ring containing the three jaws can be replaced by the removal of one screw. The clutch is so designed that it is impossible to insert any part in any but the right position.

The upper carbon-holder is combined with the trolley which carries current to the upper carbon and consists of a phosphor-bronze vertical split holder, ensuring even distribution of pressure on the part of the carbon covered by its jaws. The lower end of the solid piece of brass on which these jaws are mounted projects downward between the jaws and serves as a stop for the upper carbon and prevents its entrance into the holder beyond the correct position. No part of the holder can rust or get out of order. No steel springs are used in its construction, and should it become damaged it can be easily replaced by the removal of two screws. The trolley of the lamp is made from a solid piece of brass with circular grooves milled therein at angles of 120 degrees apart. These grooves contain the semi-circular contact springs which protrude above the grooves and make edgewise contact with the carbon tube. The planes of these edges are at right angles to lines passing through the centre of the body of the trolley. This form of construction prevents corrosion and accumulation of dust and dirt between the surfaces of the trolley springs and the carbon tube.

In trimming the lamp the carbon is automatically centered and the surface of the contacts between the trolley springs and the carbon tube is automatically cleaned. In the top of the carbon tube is a nut, on the lower surface of which is a projection which enters the centre opening in the top of the body of the trolley or carbon-holder, thus always centering the carbon without any special effort on the part of the attendant.

The adjustment of the length of the arc is accomplished by the adjusting coil in shunt with the series magnet coil. On loosening one screw the adjusting clamp may be lowered or raised, increasing or decreasing the amount of current passing through the series coil, causing it to oper-

ate at a longer or shorter arc, as may be desired.

The gas cap of this lamp is made of two parts, thoroughly insulated from each other, so that there is no difference of potential on its top. This is an important point, as a gas cap constructed so that there is a difference of potential on the top sooner or later causes trouble on account of short-circuit created by the collection of dust and dirt. The opening in the gas cap through which the upper carbon passes is provided with a copper bushing, easily removed should it become damaged.

The binding-posts are of ample proportion and are provided with porcelain petticoat insulators and a rubber insulating washer which makes the joints watertight. They are further provided with set screws for clamping the wires in a vertical position, so as to make a strong mechanical as well as a good electrical connection.

One of the most attractive features of this lamp is the ease with which it can be dismantled should repairs become necessary.

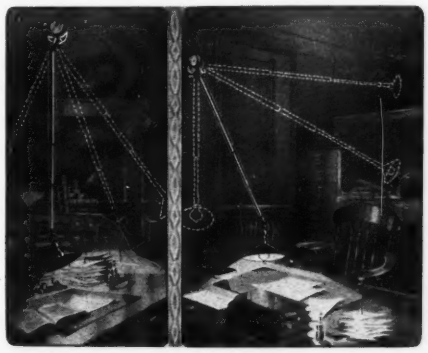
By the removal of five screws, two brass spring cotters and a clamping nut on the bottom of the clamping tube the entire bottom part of the lamp below the radiator can be removed from the carbon tube, leaving only in connection therewith the armature, the shunt and series coils with their castings and the cast-iron top. The magnets, armature and casting upon which they are mounted can be easily removed from the carbon tube by removing the cast-iron cap, two spring cotters and four screws. The cast-iron top can be removed by simply taking off the binding-posts. The trolley and carbon combined can be released by removing the cast-iron top and taking off one nut. By the removal of the outer globe and the cylindrical case all sides of the mechanism are exposed. In fact the lamp is so constructed that any part of it is rendered accessible by a few moments' work. All the nuts in the lamp are made the same size, a fact that will be appreciated by the repair man.

The entire lamp is so designed that it will remain in service a maximum period before a complete overhauling is necessary. This is accomplished by operating at a low temperature and in general by its substantial and well-finished construction.

As will be seen from the above description the leading features of this lamp are its extreme simplicity, small number of wearing parts, substantial construction and consequent long life.

An Electric Lamp Shifter.

Many ingenious devices have been placed upon the market recently to enable the consumer to utilize his electric lighting apparatus to peculiar and particular advantage, and in the accompanying illustration will be noticed the electric lamp shifter manufactured by the Kemmerer Electric Light Shifter Company, of



Lamp Shifting Device.

Weissport, Pa. This apparatus is particularly recommended by the maker to dentists, draftsmen, doctors, surgeons, machinists, students or any operator who needs a light in some advantageous position or wants a range of positions which is flexible in the extreme.

With this shifter on the ceiling or wall of a fourteen-foot square room, it is claimed that the light can be extended to any corner and remain where it is placed without adjusting nuts, set screws or other apparatus.

Wire Reels.

The "Ready" tandem pay-out reels, illustrated in the accompanying illustrations, are made entirely of iron, having

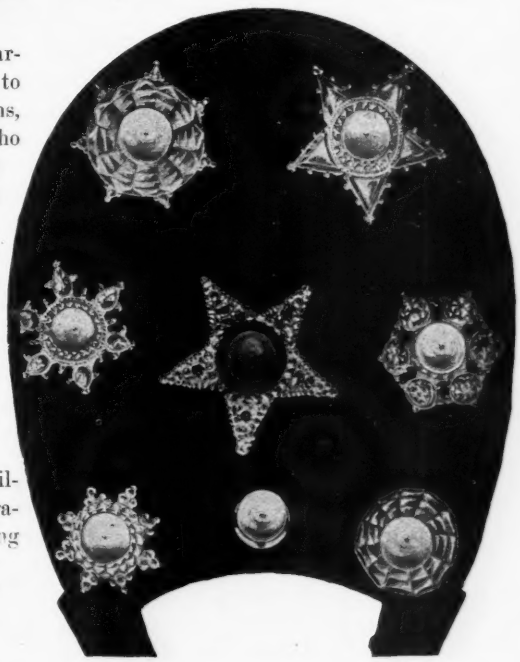
An All-Iron Tandem Pay-Out Reel.

cone bearings, and are adaptable for any size coil of wire. This reel is of the tension type, being adjustable, and prevents the possibility of wire paying out too freely. The tandem reels are especially adapted for toll line and drop work. These reels are made in twelve styles, adapted to all requirements of telephone, telegraph and electric light companies.

These reels are manufactured by the W. G. Nagel Electric Company, Toledo, Ohio, which also manufactures tools, pole houses, pole seats and balconies, besides being jobbers in all kinds of telephone, electric light and street railway supplies.

Novel Lighting Reflectors.

The Amal reflectors, a few of which are shown in the accompanying illustration, are an entirely new product—a combination of metals that enables the manufacturer to make all sizes and kinds of reflectors either plain or in metal for incandescent lamps. The numerous small facets and the brilliant polish which may be secured make the best reflecting surface for this kind of work.



New Form of Lighting Reflectors

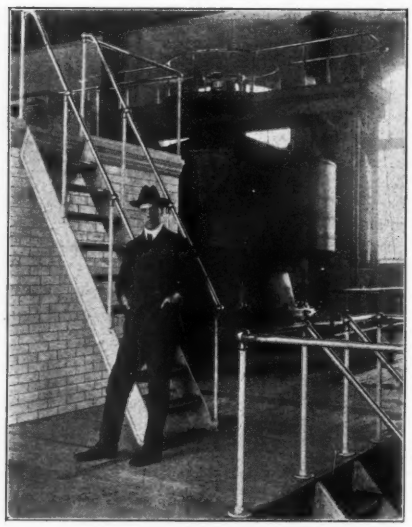
These reflectors may be made up into beautiful designs, and plain lamps may be made to form the most picturesque types of adornment, while colored lamps are produced in the form of almost any definite number of gems. These are used principally for decorative purposes, and give especially good effects when placed on lamps in show-windows, and also make up handsomely in advertising work. These reflectors are claimed to be non-breakable and are not subject to corrosion, and the reflecting surfaces are susceptible of being rubbed or polished without deterioration. These reflectors are a specialty of the A. A. McCreary Company, New York city.

MR PAUL M. LINCOLN.

BY ARTHUR B. WEEKS.

The resignation of Mr. Paul M. Lincoln as resident electrician of the Niagara Falls Power Company will be in the nature of a surprise to many of his acquaintances and friends. He left the Power company at Niagara Falls on May 15 to accept a position with the Westinghouse company, at Pittsburg, Pa.

Mr. Lincoln began the work of installing the dynamos at the power-house in February, 1895, and by him the entire work of the electrical portion of the plant was successfully carried through. The many new problems which, in an initial work of this kind, necessarily faced him, were one by one worked out with gratifying success, and it is largely through Mr. Lincoln's ability that the operation of the power-house has thus far been so satisfactorily carried out. Associated with him in the installation were Messrs. W. K. Dunlap, S. B. Storer, J. T. Haskin and W. F. Lamme, all of the Westinghouse company.

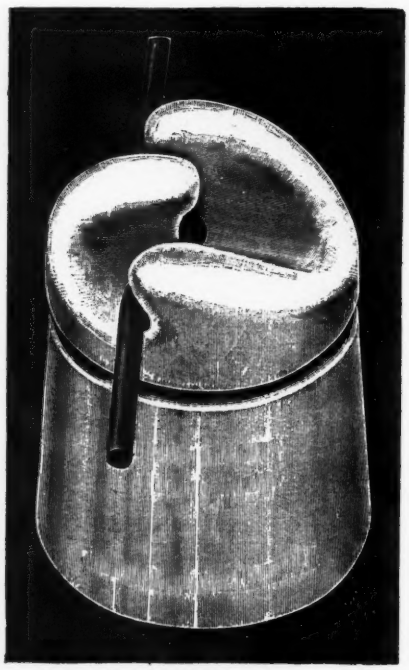


MR. PAUL M. LINCOLN.

Mr. Lincoln is a member of the American Institute of Electrical Engineers, the American Electrochemical Society and other organizations. His name has become familiar through recent important electrical devices patented by him, one of the best known being the Lincoln synchronizer, which is being widely and successfully used. The accompanying photograph shows Mr. Lincoln standing near the switchboard staircase, at the power-house, with one of the great 5,000-horse-power Niagara Falls dynamos in the background.

Porcelain Insulators and Insulating Cotton Sleeving.

Among the latest improvements in construction material for outside lines may be noticed the self-tying porcelain insulator for pin and bracket lines, and the new insulating cotton sleeving for covering conductors in making joints in cables, which are being put on the market by James S. Barron & Company, of New York city. Referring to the illustrations, Fig. 1 shows a reduced engraving of the pony insulator. The rapidity with which these insulators can be put up and taken down, and the feature of their design, which makes a consequent saving in time of tying wires, are important items to be considered in estimating the costs of lines. The manufacturers especially recommend these for army service, where rapid work is necessary both in putting up and taking down for transporting to other localities.



(Pat. March 21, 1899.—Pat. March 12, 1901).

FIG. 1.—SELF-TYING PORCELAIN INSULATOR.

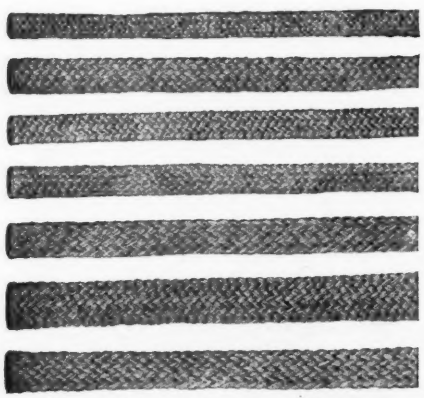


FIG. 2.—COTTON INSULATING SLEEVES.

These self-tying insulators are made in porcelain in several sizes to accommodate the different wires used for electric light and power plants, as well as for telegraph and telephone service, and will also be furnished in glass when desired.

Fig. 2 shows some of the sizes of a woven cotton insulating sleeving. These are put up ordinarily on cones holding about ten pounds each. The lineman or repair man, in making a joint, cuts away about three inches of this tubular sleeving, carrying it back away from the bared portion of the wire, the sleeving having previously been soaked in paraffin. After the joint has been made the sleeving is drawn back over the exposed portions of the wire or cable, when the sleeving, under the solidifying of the paraffin, makes an impervious jacket over the joint. These are then covered with the usual lead pipe, making a highly satisfactory insulated joint, and embodying the extra feature of being capable of very rapid application.

The American Society of Mechanical Engineers.

The forty-fifth meeting of the American Society of Mechanical Engineers will be held in Boston, Mass., May 27 to May 30, 1902. The headquarters will be at the Hotel Brunswick, Clarendon and Boylston streets. Arrangements have been made with the principal railway associations by which those attending this meeting may secure the rate of one and one-third fare according to the certificate plan. An interesting programme of events has been arranged for the different sessions which will include many visits and trips to different points of interest in and around Boston.

The Ohio Society of Mechanical, Electrical and Steam Engineers.

At the third meeting of the Ohio Society of Mechanical, Electrical and Steam Engineers, held at Mansfield, Ohio, on May 10, a large gathering of the representative engineers of this section of the country were in attendance. The society is now about six months old and is in very excellent condition, showing admirable prospects for future growth. Among the interesting topics for consideration at this meeting was a paper by Elmer E. Miller, district examiner of steam engineers for the state of Ohio, on "Suction and Delivery Pipes, Air and Vacuum Chambers on Steam Pumps." A paper on "Recent Refinements in Field Magnet Construction" was also read by S. E. Heunerfauth, superintendent of the Card Electric Works, Mansfield, Ohio, and a short paper was read and discussed by Ezra Fawcett, of Alliance, Ohio, on "Electric Machinery." The next meeting will be held at Canton, Ohio, on November 15, 1902.

CURRENT ELECTRICAL NEWS

COMMERCIAL NEWS

DOMESTIC AND EXPORT

STREET RAILWAY CONSOLIDATION—A certificate has been filed with the Secretary of State at Trenton, N. J., recently by the United Railway Investment Company, of San Francisco, increasing its capital from $2,500 to $25,000,000. The papers were signed by Thornwall Nullally, president, and Ernest P. Hoes, secretary. The company was originally incorporated in February last and its object, it is understood, is to consolidate the trolley lines in and about San Francisco. A provision in the amended charter filed provides that the preferred stock may be retired at the end of three years by the payment of 110 per cent.

ANOTHER LARGE PLANT FOR MASSENA—It has been announced that the Pittsburg Reduction Company has secured 100 acres of land at Massena, N. Y., and will at once erect five large factories, to cover at least fifteen acres of its land. The principal article of manufacture will be aluminum, and it is expected that employment will be given to a large number of men throughout the year. The Massena factories will probably be the main plant on account of the shipping facilities both by water and rail, and the abundant electrical power available. The expenditure will probably reach over $1,000,000. It is expected that the buildings will be enclosed by fall and the works in operation by April of next year.

WIRELESS TELEGRAPH BIDS—In response to an invitation sent out some time ago by the United States Signal Corps, five different companies have made estimates for the establishing of the system in Alaska. The bids run all the way from $9,919 to $11,005 for individual routes up to $28,000 for four sets of apparatus. The manufacturers of apparatus in Germany have intimated their intention to submit a tender, but this it is believed has not arrived as yet. It is expected, however, that the bids will be held open until the foreign makers are heard from. The government desires to establish only two wireless telegraph routes in Alaska, but in the bid the various companies are given their choice of four. Only one company offers to perform the work and furnish the material without omission of any sort, its bid covering everything that is to be done or furnished.

POWER PLANT TO BE SOLD—Despatches from Utica, N. Y., announce that Guthrie, Cravath & Henderson, of New York, representing the complainants in the foreclosure action brought by the Commercial Trust Company, of New York, and the Morristown Trust Company against the St. Lawrence Power Company at Massena, N. Y., the Standard Trust Company and the United States Mortgage and Trust Company have obtained a decree in foreclosure and sale from Judge Cox in the United States Circuit Court. Jas. D. P. Lynch was appointed as master, and he will sell the power plant at Massena in about six weeks. The judgment order provides for rejection of bids under $500,000. There has been no opposition to ordering the sale of the property. The foreclosure suit was brought by the first and second mortgage bondholders, but a plan has been projected for a reorganization, and it is understood that the sale of the property will not affect the big power scheme.

ELECTRIC LIGHTING AND POWER IN VENEZUELA—The principal electric plant, operated by water power, in Venezuela is located at El Encantado, twelve miles from Caracas. During the rainy season it develops 400 horse-power, but from December to April this is reduced to 100 horse-power or less, as in the dry months the water is used for irrigating the adjoining land. Three vertical turbines are employed, and the generators are alternating current, developing about 5,000 volts. Most of the apparatus is of Swiss manufacture, Italian firms having furnished the conducting wires. Another enterprise is at Merida, where only about 150 horse-power is developed. All the machinery is American made, and direct current. San Cristobal has an electric station of 200 horse-power to light the city and furnish power for a few industrial firms. Using steam as motive power, in Caracas is the Compania de Gas y Luz Electrique de Caracas. This company has a capital of $443,900 and has a capacity of about 300 horse-power, using four tons of patent fuel daily and 7,350 gallons of water. It supplies ninety-six arc lamps of 2,000 candle-power which are used in the streets, and 4,000 incandescent lamps of sixteen candle-power for private houses. The electric plant at Maracaibo furnishes current for 300 arc lights of 1,000 candle-power, and about 4,000 incandescent lamps. At Valentia and Puerto Cabello there are similar plants.

MINING UNDER THE EDISON PATENTS—The Dunderland Iron Ore Company's prospectus has been announced. The capital of the company is £2,000,000, made up of 200,000 six per cent cumulative preference and participating shares of £5 each and a like number of ordinary shares of the same denomination. The president of the company is Sir David Dale, Bart.; the vice-president, Joseph Lawrence, M. P., formerly president of the Edison Ore Mining Syndicate, which was the original concern formed some three years ago to acquire the Edison ore-treating patents for Norway and Sweden. The other directors of the company are: William Armstrong, George Ainsworth, Herman Ernest Dick, James F. Mason, Walter Stoen, Bright McLaren, Edward W. Richards and I. Williams. The technical advisers of the company are Thomas A. Edison and Lord Kelvin. Some 80,000,000 tons of crude ore are said to have already been found available for mining. In addition, it is believed that the deposits not yet proved contain at least a further 100,000,000 tons of ore. These deposits are situated on the west coast of Norway, at distances varying from three to thirty-five miles from the port of Mo, on the Ranen Fjord. A railroad is to be constructed from the mines to the coast so as to facilitate the shipments of the ore. The power available is estimated to be about 40,000 horse-power. It is planned to originally equip a plant designed by Mr. Edison to concentrate 1,500,000 tons of crude ore, and provide 750,000 tons of briquettes per annum.

AUTOMOBILE NOTES

A SUMMER CLUB ROOM—The Automobile Club of America has secured a club room in the Garden City Hotel, Garden City, for the exclusive use of its members, who will have all the privileges of the hotel, including the swimming pool, shower baths, billiard room and charging and storage facilities.

A PRIVATE SPEEDWAY FOR FAST AUTOMOBILES—It is believed that a plan is under way to build a speedway for the exclusive use of automobiles between Long Island City and Garden City, L. I. It has been announced that the supervisors of Suffolk County will welcome the advent of such a speedway and will do all in their power to help the project along, as it will probably be a factor in developing some of the comparatively unknown localities on the island which are now familiar only to the deer hunter and the cycling tourist.

THE MILE RECORD CONTEST—The Automobile Club of America will hold a mile record contest on the South Shore Boulevard, near Grant City, Staten Island, N. Y., at 11 A. M., Saturday, May 31, 1902, for all classes of motor vehicles. The contest will be held under the racing rules of the American Automobile Association. Entry blanks will be furnished on application to the club secretary, the time for receiving entries expiring on May 24. The entry fees will be as follows: For motor bicycles and tricycles, $5 for each vehicle; for other classes, $10 for each vehicle. The entrance fees must be paid to the treasurer of the club at the time application for entry is made. Should the weather be such as to make it impossible to hold the contest on schedule time, it will be postponed until the following Monday, June 2. Vehicles will be divided into eight classes as follows: (1) Motor bicycles carrying one person, (2) motor tricycles, (3) gasoline vehicles under 1,000 pounds, (4) gasoline vehicles 1,000 to 2,000 pounds, (5) gasoline vehicles over 2,000 pounds, (6) steam vehicles all weights, (7) electric vehicles all weights, (8) free for all, any weight, any power, against time. As prizes, silver medals will be awarded to the vehicles making the best time in the bicycle and tricycle classes; gold medals to the vehicles making the best time in the gasoline, steam and electric classes; silver medals to the vehicles making the second best time in gasoline, steam and electric classes; bronze medals to the vehicles making the third best time in the gasoline, steam and electric classes. In class eight, free for all, no medals will be awarded. A certificate, however, stating the time will be given. Albert C. Bostwick is the chairman of the racing committee.

ELECTRICAL SECURITIES

Although the average conditions which would seem to make for prosperity have been evidenced of late, the situation in the market generally has been one of bearish development. The adverse developments in the coal situation probably have had much to do with this, but there has been a decided relaxation in the money market, and an extremely favorable crop report would seem to reflect a decided improvement in conditions. General trade reports have been very promising, and export trade has shown indications of a decided and marked revival. This is due and traceable to the improving trade conditions prevailing in foreign countries, which naturally increase the buying demand for American products. The course of prices for the week has been persistently downward as compared with a week ago. The public has not recovered from its suspicion and distrust, caused by the collapse of certain industrials very recently, and there has been small animation by this element to enter into speculative dealings. New developments in the coal strike situation will in all probability be the dominant factors for some time, although from almost every source of information it would appear that the strike will be of short duration. The operators, for some months preceding the final decision of the workers, prophesied that there would be no difficulty in making satisfactory arrangements, and there is great disappointment evinced on all sides that matters have taken such a decided turn. However, the miners themselves are not, as a whole, very much in favor of an aggressive movement and this is believed to point to an early settlement of the present difficulty.

The government reports of foreign trade for April show an excess of exports of $33,000,000, as against $44,000,000 for the same month last year. For the ten months of the fiscal year ending May 1, the total excess of exports over imports was $435,000,000, or a decrease this year of $149,000,000. The April statement, however, shows a decided improvement over that for March, as the March decrease was about $16,000,000, as against a decrease for April of $11,000,000. The increase in imports is very small, and it is probable that imports are very close to the maximum, while exports may be expected to increase for the balance of the year, particularly if good crop conditions continue.

ELECTRICAL SECURITIES FOR WEEK ENDING MAY 17.

New York:	Closing.
Brooklyn R. T.	64¾
Con. Gas	220¾
Gen. Elec.	315
Kings Co. Elec.	196
Man. El.	131¼
Met. St. Ry.	146¾
N. Y. & N. J. Tel. Co.	173
Westinghouse Mfg. Co.	218

The annual meeting of the stockholders of the General Electric Company has been held at the office of the company in Schenectady, and the old board of directors was reelected. As a quorum of this board was not present no meeting of the board was held.

All of the electrical stocks listed declined. The most significant electrical stock was General Electric, which in the early part of the week sold down a number of points and then made a rapid rise to 328. At the end of the week it stands six points lower than at the close of the preceding week.

Boston:	Closing.
Am. Telep. & Tel.	178
Edison Elec.	280
Mass. Elec. pf.	96
New England Tel.	146
Western Telephone & Telegraph.	105

The principal feature of the week in the local market has been the activity and strength shown by Massachusetts Electric common, the preferred seeming to have settled down on an investment basis, while the common is being bought freely by investors who believe it is going to be very valuable in some not far distant day. The stockholders of the Edison Electric Illuminating Company have approved an issue of 16,500 additional shares of stock, which will mean $3,300,000 should the gas commission authorize the stockholders to subscribe for the stock at the same figure as the last issue, namely, $200 a share.

Philadelphia:	Closing.
Elec. Co. of America	7
Elec. Stor. Bat. c	82
Elec. Stor. Bat. pf	83
Philadelphia Elec.	5⅜
Union Traction	40⅝
United G. I. Co.	103

Chicago:	Closing.
Chicago Edison Light	172½
Chicago Telep.	170
Metropolitan El. pf.	90
National Carbon	25¼
National Carbon pf.	91
Union Traction	18¾
Union Traction pf.	51

ELECTRIC LIGHTING

COLUMBUS, OHIO—The city council has passed an ordinance which provides for the sale of $175,000 bonds for a new municipal light plant.

TAUNTON, MASS.—An order appropriating the sum of $175,000 for the enlarging and extension of the municipal lighting plant has been passed by the city council, and it appears now that a new plant is practically assured.

GUTHRIE, O. T.—The Guthrie Light and Power Company has been bought by the La Fayette bank interests of St. Louis. The new company will at once improve the plant to give a day service, the improvements being estimated to be about $35,000.

BRADNER, OHIO—The city council has been instructed to canvass bids for the construction of a municipal electric lighting plant and waterworks. It is not known whether the bids will exceed the appropriation, which at the present time is stated to be $13,500.

LUBECK, ME.—At a special meeting of the selectmen recently held, a franchise was granted the Drew Machinery Agency, of Manchester, N. H., giving the concern the right to erect poles and run wires throughout the town for the purpose of furnishing electricity for lighting and mecnanical purposes.

REDDING, CAL.—One of the oldest gold mines in the country is to be supplied with an electric plant and work on the property resumed with increased activity. The property referred to is the Gladstone mine in the French Gulf District. It is the plan to install a complete electric plant for the creation of 500 horse-power at the mine. The power will be used to run the mine, mill, and light the entire plant.

SAN JOSE, CAL.—The San Jose Light and Power Company and the Electric Improvement Company have passed into the control of the United Gas and Electric Company, of San Francisco. The consideration involved is $1,250,000, of which $700,000 goes to the Improvement company. The owners plan to combine the various electric and gas plants in this city into one concern. In addition they will erect a $250,000 electric distributing station.

ALBANY, N. Y.—A certificate of incorporation of the Utica Gas and Electric Company, of Utica, with a capital of $2,000,000, has been filed with the Secretary of State. The company is to do a general lighting business in Utica and Oneida and Herkimer counties. The directors are said to be A. N. Brady, Albany, N. Y.; Wm. F. Lewis, John F. Maynard, Chas. S. Symonds, Wm. T. Baker, Chas. B. Rogers, M. J. Brayton, D. N. Crouse, and Samuel A. Beardsley, all of Utica.

NEW ALBANY, IND.—The United Gas and Electric Company, of New Albany and Jeffersonville, has filed articles of incorporation. The capital is $1,000,000, divided into 10,000 shares. The incorporators are: Samuel Insull, of Chicago, president of the Chicago Edison Company; W. B. Hummer, of La Salle, Ill.; Robert W. Wait; J. W. Dunbar, of Chicago, and John Tevis, of Louisville. It is said that Mr. Insull will be president of the new corporation. The company will control the gas and electric light plants of New Albany and Jeffersonville, and it is stated will also establish heating plants in each city.

OBITUARY NOTICE

MR. CLARENCE E. STUMP died at his home in Flushing, L. I., after a short illness, on May 15. Mr. Stump has long been well known in technical and other fields of publishing. During his earlier career he was associated directly with several journals in the electrical field, and of late he has been assistant business manager of the *Christian Herald*. Mr. Stump was forty-seven years old at the time of his death. His loss will be felt by a large number of friends throughout the electrical field, in which Mr. Stump was known from one end of the country to the other and well beloved for his geniality, heartiness and kindness.

PERSONAL MENTION

DR. S. S. WHEELER, of the Crocker-Wheeler Company, Ampere, N. J., sailed for England on the Celtic on Friday, May 16, and will enjoy a vacation of several weeks in foreign countries.

MR. W. T. MCDOWELL, who has recently been identified with the Electric Motor and Equipment Company, of Newark, N. J., has joined the selling organization of the Manhattan Electrical Supply Company, of New York.

MR. C. VANDEVENTER has left the New York office of the Stanley Electric Manufacturing Company to take the management of that company's office in Chicago. Mr. Vandeventer was tendered a farewell dinner by his office associates and friends at the Hotel Normandie, New York city, on the evening of Monday, April 28.

MR. J. C. CHAMBERLAIN, well known in storage battery and electric launch circles, has resigned as general manager of the Electric Launch Company, and Mr. Henry R. Sutphen succeeds him and takes charge of the practical affairs of the company as general manager. Mr. Chamberlain, who is a well-known and authoritative expert in this field of work, will take a rest of a few months, during which time he will visit various points of electrical interest in the United States, including the Pacific coast.

DR. F. A. C. PERRINE on the evening of Friday, May 9, read a paper before the Boston Society of Arts at the Massachusetts Institute of Technology, on "Success in Long-Distance Power Transmission." The special features of the paper were the obstacles and difficulties met with in the engineering of the great transmission lines, and the details of their successful solving. On the following morning before the senior class in electrical engineering, his address was on the outlook in electrical engineering, the theme being the prospect for young engineers.

IN THE REMARKS of the toastmaster at the recent dinner to Lord Kelvin by Mr. Anthony N. Brady, graceful compliments were extended to a number of distinguished electricians sitting around the board. Mr. Edison, who was at the opposite end of the table, and who is, as is well known, hard of hearing, was applauding impersonally the sentiments of the speaker, and when his own name was mentioned, evidently not catching it, applauded as vigorously as any one, until his wife whisperingly made him understand that he was applauding his own name. The confusion of the veteran inventor was quite evident for a moment and was enjoyed by all observers. He soon realized, however, that it was a good joke on himself and chuckled over it as much as any one.

DR. LOUIS DUNCAN has been appointed head professor of electrical engineering in the Massachusetts Institute of Technology, at Boston. Doctor Duncan has been known for several years as one of the most prominent and active members of the consulting engineering profession. Originally a graduate of the United States Naval Academy at Annapolis and an officer in the United States Navy for several years, Lieutenant Duncan was one of the earlier students of Professor Rowland of the Johns Hopkins University, at which institution he took his doctor's degree. Upon his graduation, he was selected to fill the newly created chair of electrical engineering in that institution and for several years was in charge of its classes and laboratory equipment in this branch of study. Resigning several years ago from the service of the university, he established himself in New York as consulting electrical engineer. Among the more important works which he has been engaged upon may be mentioned his appointment as consulting electrical engineer for the New York Rapid Transit Commission, the Baltimore & Ohio Railroad, and for a large number of electric railway systems in the western states. Doctor Duncan was the designer of the electrical locomotives now operating in the tunnel of the Baltimore & Ohio Railroad under the city of Baltimore. In his new appointment he will bring to the conduct of his classes a large acquaintance with actual electrical engineering and with the most recent developments of the subject. Among the other large enterprises which have lately engaged his attention is the construction and equipment of the Keystone Telephone Company's plant and exchanges in Philadelphia. Doctor Duncan was noted, during his brief term of service as an instructor at the Johns Hopkins University, as one of the most practical teachers of his subject in the country. Among his graduates there are numbered many of the men who are now occupying foremost positions in the various branches of electrical engineering in the United States and other countries. His acceptance of the position of professor of the reorganized courses of the Massachusetts Institute of Technology will doubtless mark a new era in the history of the subject as presented at that institution. He combines, in a large degree, knowledge of his chosen subject with an attractive personality and an ability to make his influence felt by his students and those in contact with him.

INDUSTRIAL ITEMS

THE STERLING ARC LAMP COMPANY has removed its office to the St. James Building, New York city.

THE CENTRAL ELECTRIC COMPANY, Chicago, Ill., is in a position to ship from Chicago stock all orders for Westinghouse lightning arresters. The company will be pleased to send descriptive catalogue upon request.

THE HUNTER FAN AND MOTOR COMPANY, Fulton, N. Y., reports that it has been very successful in placing orders for this season's apparatus. The company has been forced, under the demand for its product, to work its factory at night for the last few months.

THE AMERICAN STEEL AND WIRE COMPANY has issued two splendid catalogues on springs and rail bonds. These catalogues are both elaborately illustrated and contain full descriptive matter to give a comprehensive idea of both descriptions of this company's product.

THE WILHELM MANUFACTURING COMPANY, Buffalo, N. Y., has issued a very complete catalogue describing and illustrating its interior telephone systems. This company makes a specialty of reequipping systems, and making complete automatic intercommunicating telephone designs.

THE NORTHEASTERN TELEPHONE COMPANY, which was formerly the Dirigo Telephone Company of Maine, is sending out a prospectus describing the character of its corporation and dispensing general information as to the independent telephone movement in the service under its control.

THE BRISTOL COMPANY, Waterbury, Ct., has issued a fine catalogue of its recording electrical instruments. This catalogue covers complete lines of recording volt, ampere and wattmeters for both alternating and direct currents. Copies will be sent to any who are interested, on request.

THE AUTOMATIC ELECTRIC COMPANY, Chicago, manufacturer of automatic telephone apparatus under the Strowger patents, has been apprised by cable that the London postal authorities have authorized the installation of one of its automatic telephone exchanges in the London post office.

THE AMERICAN PATENTS PUBLISHING COMPANY, Washington, D. C., is issuing "The American Electric and Automatic Patents Monthly," including air and gas engines and the acoustics. This is a most comprehensive publication, being very fully illustrated, and is compiled by James T. Allen, examiner United States Patent Office.

RUMSEY & COMPANY, Seneca Falls, N. Y., has recently issued the fifty-third edition of a most comprehensive catalogue of its products. This, the 1902 edition, contains 256 pages of information, including descriptions and prices of a complete line of hand and power pumps, hydraulic and pumping machinery for all purposes.

THE SPEER CARBON COMPANY, St. Marys, Pa., has made a number of improvements in its factory during the past year, and is now operating almost to its fullest capacity in the production of electrical carbons, particularly in the manufacture of the Speer motor brush, electric light carbons and other carbon specialties.

THE CONSUMERS' CARBON COMPANY, Lancaster, Ohio, manufactures electric light carbon and carbon specialties of every description. These carbons are perfectly made, smooth burners and long lived. The company has splendid facilities for promptly filling orders from stock, and states that a steady demand is keeping its large factories running full time.

THE NORTON TOOL COMPANY, West Park, Ohio, a manufacturing company just entering the electrical field, is placing on the market a patented galvanized steel cable hanger for telephone and telegraph construction work. These hangers are claimed to be easily put in position and permanent in their service. The company also manufactures corner brackets and special forgings.

THE ELECTRIC APPLIANCE COMPANY, Chicago, Ill., is the general sales agent for the Packard "Mogul" incandescent lamps, which are made in 200, 300 and 500 candle-

power. This company states that there is a steadily increasing demand for these lamps which are being substituted for groups of sixteen-candle-power lamps and in some instances for the incandescent arc lamps.

THE PHELPS COMPANY, Detroit, Mich., is the manufacturer of the Hylo turn-down electric lamp. The Hylo has two light-giving carbon threads, one of ordinary size making sixteen candle-power and one exceedingly small making one candle-power. The least turn of the Hylo bulb in its socket puts out the large filament and lights up the small filament. A Hylo fits ordinary fixtures and can be used in any place where a common electric lamp has been fitted.

THE RELIANCE ELECTRICAL COMPANY, Milwaukee, Wis., announces that among the orders recently secured might be mentioned the equipping with generators and motors of the Duncan Electrical Company, of La Fayette, Ind., the Milwaukee Corrugating Company, and the Chicago Opera House. The Reliance Electrical Company has established connections with London and Manchester, England, and reports a number of orders as coming from these places.

THE FOSTER ENGINEERING COMPANY, Newark, N. J., is meeting with a brisk demand for its valves. In equipping the new power station of the New York Edison Company orders have been placed with the Foster Engineering Company for one 8-inch and four 10-inch combination valves, and two 8-inch and one 10-inch non-return stop valves. The Cleveland Electric Company has also awarded a contract to the Foster company for four 8-inch non-return stop valves.

THE INTERNATIONAL MOTOR CAR COMPANY, Toledo, Ohio, has placed a number of automobiles for military use for British officers at South African points. These are mostly heavy steam carriages. The Waverly department has recently supplied General Lew Wallace, the historian novelist, with a Waverly standard electric runabout. This is a handsome machine, and all 1902 models are being fitted with electric brakes which make operation in the most crowded sections under the most sensitive control.

"THE FOUR-TRACK NEWS" for May contains a graphic description of the beauties of the Yellowstone, by O. D. Wheeler. "One Hundred Years at Westpoint" is interestingly portrayed by Jane W. Guthrie, and Mr. George H. Daniels gives a timely and interesting study on rapid transit in New York. There are other good things too numerous to mention in this splendid publication which is designed particularly to embrace in short measure comprehensive and entertaining sketches on topics of great interest.

THE KELLOGG SWITCHBOARD AND SUPPLY COMPANY, Chicago, Ill., has a contract to equip the Pekin Telephone Company with a 300-line magneto self-restoring dropboard. A 3,000-line common battery switchboard with all necessary apparatus will be supplied to the Gas Belt Construction Company in Muncie, Ind. This company will also install a Kellogg 1,800-line apparatus in Elwood, Ind. The company has issued to the telephone public a magnificent general descriptive catalogue. This is tastefully bound and is replete with splendid half-tone illustrations, and comprehensive descriptive matter is given to the showing forth of miscellaneous apparatus.

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia, Pa., has announced the opening of several exide battery depots for the purpose of caring for, charging and furnishing vehicle batteries of its manufacture. The stations already announced are situated in New York city at 148 West Eighteenth street; at Philadelphia, 250 North Broad street; at Buffalo, 200 Pearl street; at St. Louis, 3937 Olive street; and at Chicago, 264 Michigan Boulevard. The company contemplates opening immediately stations in a number of other cities. These stations will be equiped with a stock of battery material and will be under the charge of experienced battery men.

THE SHELBY ELECTRIC COMPANY, Shelby, Ohio, owing to increased business, has removed its Chicago office to 79 Dearborn street. It has installed at this address one of the most complete testing laboratories in the West. The photometer is a large laboratory type, this instrument having illuminated dials and long scales, being a combination of a laboratory-switchboard type. A motor-generator is used to step the voltage up, which is automatically regulated, from 110 to 260 volts, if necessary. Considerable other apparatus is used in connection with the above, all being especially designed by different well-known instrument makers.

THE WESTERN ELECTRICAL SUPPLY COMPANY, St. Louis, Mo., has just issued a very complete telephone catalogue. The volume comprises nearly 200 pages. It is handsomely bound and is devoted exclusively to telephone apparatus and telephone line and construction material. It reports a large number of new, up-to-date devices which have not been illustrated heretofore. This company states that it is now carrying a very large and complete stock of telephone line and construction material and is prepared to furnish promptly from St. Louis stock anything illustrated in the catalogue, which certainly covers everything which might pertain to the operation, maintenance or equipment of telephone lines and exchanges. This catalogue will be mailed on application.

THE OSBURN FLEXIBLE CONDUIT COMPANY, 21 Park Row, New York, reports a rapidly increasing acceptance by electrical engineers of the new flexible conduit for interior wiring, known as "Flexduct." Within the first year of its manufacture it has gained the fullest official approval from the boards of fire underwriters and many other experts. The character of the conduit, which has been previously described in these columns, is claimed to be of such a nature that the interior can not be ripped out because it is an inseparable part of the conduit, which feature prevents the possibility of ripping out the inside when installing wires too large for the conduit or when fishing wires through it. It is said to be positively moisture-proof because of its texture being so closely woven together with a special fibre and a special warp, which is afterward treated with a compound to fill up the pores.

THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, Pittsburg, Pa., will begin immediately the construction of new buildings at East Pittsburg which will greatly increase the size of its works. The new buildings will be known as the East Extension, and the plan also requires the building of a river wall below the works of the Westinghouse Machine Company. Arrangements have also been entered into with the Pennsylvania Railroad whereby a special railroad line will be built from East Pittsburg to the Westinghouse foundries which are now being installed at the town of Stewart, several miles to the east. This railroad will be built for the exclusive use of the Westinghouse companies. The construction of this large enterprise has been entrusted to James Stewart & Company, of Pittsburg, whose achievement in erecting the new Westinghouse electric works at Manchester, England, excited so much comment recently.

THE SPRAGUE ELECTRIC COMPANY, New York, reports a busy season and among recent sales the following orders for split-pole generators may be mentioned: E. L. Epperson Construction Company, Mo., 200-kilowatt, engine type, 200 revolutions per minute, 550 volts; Chillicothe Street Railway Company, Chillicothe, Ohio, 300-kilowatt, belted type, 450 revolutions per minute, 550 volts; Cosmopolitan Power Company, Chicago, 75-kilowatt, belted type, 600 revolutions per minute, 250 volts; Ohio Powder Company, Youngstown, Ohio, 100-kilowatt, belted type, 585 revolutions per minute, 500 volts; Keystone Leather Works, Camden, N. J., 200-kilowatt, engine type, 200 revolutions per minute, 230 volts; Providence & Danielson Railway Company, Providence, 400-kilowatt, belted type, 400 revolutions per minute, 575 volts; Board of Education, Chicago, two 150-kilowatt, engine type, 225 revolutions per minute, 115 volts; E. W. Bliss Building, New York, four 150-kilowatt, engine type, 225 revolutions per minute, 250 volts; Lackawanna Iron and Steel Company, Buffalo, 500-kilowatt, engine type, 100 revolutions per minute, 250 volts; St. Joseph Railway Light, Heat and Power Company, St. Joseph, 150-kilowatt, engine type, 150 revolutions per minute, 200 volts; Otis Elevator Company, Yonkers, 50-kilowatt, engine type, 290 revolutions per minute, 250 volts; The Wm. Tod Company, Youngstown, Ohio, 175-kilowatt, engine type, 200 revolutions per minute, 230 volts; Railroad Construction Company, Princeton Junction, two 400-kilowatt, belted type, 400 revolutions per minute, 575 volts; Sturges, Cornish & Burns, Chicago, 200-kilowatt, belted type, 425 revolutions per minute, 250 volts; American Electrolytic Company, Rock Glen, N. Y., 200-kilowatt, belted type, 550 revolutions per minute, 250 volts; Alfred F. Moore, Philadelphia, 75-kilowatt, belted type, 600 revolutions per minute, 125 volts; Arlington Company, Arlington, N. J., two 75-kilowatt, belted type, 460 revolutions per minute, 230 volts; one 62½-kilowatt, belted type, 470 revolutions per minute, 230 volts; one 37½-kilowatt, belted type, 500 revolutions per minute, 230 volts; Adams & Westlake, Chicago, 125-kilowatt, engine type, 250 revolutions per minute, 250 volts.